

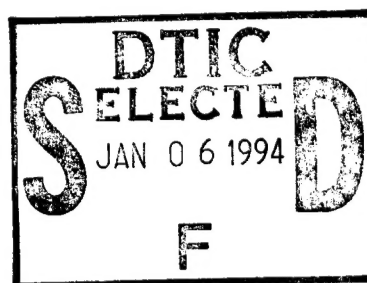
AL/OE-CR-1994-0017



**FINAL REPORT FOR SOURCE TEST MEASUREMENT OF
NITROGEN OXIDES, SULFUR DIOXIDE, CARBON MONOXIDE,
VOC, AND PM10 EMISSIONS ON GAS TURBINE #2 AT
ONIZUKA AIR FORCE BASE
SUNNYVALE, CALIFORNIA**

S. HUGH BROWN

**Pacific Environmental Services, Inc.
13100 Brooks Dr.
Baldwin Park, CA 91706**



**OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
2402 E Drive
Brooks Air Force Base, TX 78235-5114**

FEBRUARY 1994

Final Contractor Report for Period December 1993 - January 1994

Approved for public release; distribution is unlimited.

19950105 064

**AIR FORCE MATERIEL COMMAND
BROOKS AIR FORCE BASE, TEXAS**

**A
R
M
S
T
R
O
N
G**

**L
A
B
O
R
A
T
O
R
Y**

NOTICES

This technical report is published as received and has not been edited by the technical editing staff of the Armstrong Laboratory.

Publication of this report does not constitute approval or disapproval of the ideas or findings. It is published in the interest of STINFO exchange.

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely Government-related procurement, the United States Government incurs no responsibility or any obligation whatsoever. The fact that the Government may have formulated or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication, or otherwise in any manner construed, as licensing the holder, or any other person or corporation; or as conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

The mention of trade names or commercial products in this publication is for illustration purposes and does not constitute endorsement or recommendation for use by the United States Air Force.

The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

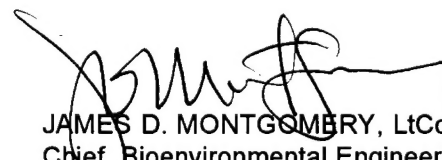
This report has been reviewed and is approved for publication.

Government agencies and their contractors registered with Defense Technical Information Center (DTIC) should direct requests for copies to DTIC, Building #5, Cameron Station, 5010 Duke St., Alexandria VA 22304-2103.

Non-Government agencies may purchase copies of this report from: National Technical Information Services (NTIS), 5285 Port Royal Road, Springfield VA 22161-2103.

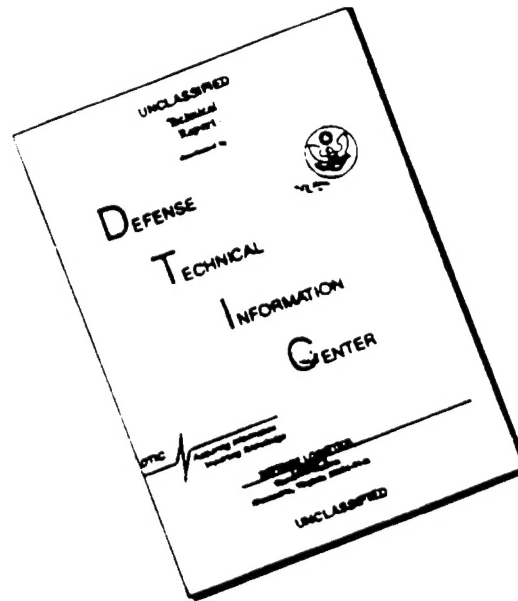


KURT D. JAGIELSKI, MSgt, USAF
Project Officer



JAMES D. MONTGOMERY, LtCol, USAF, BSC,
Chief, Bioenvironmental Engineering
Division

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST
QUALITY AVAILABLE. THE COPY
FURNISHED TO DTIC CONTAINED
A SIGNIFICANT NUMBER OF
PAGES WHICH DO NOT
REPRODUCE LEGIBLY.

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE FEBRUARY 1994	3. REPORT TYPE AND DATES COVERED FINAL, 3DEC93-12JAN94		
4. TITLE AND SUBTITLE Final Report for Source Test Measurement of Nitrogen Oxides, Sulfur Dioxide, Carbon Monoxide VOC and PM10 Emissions on Gas Turbine #2 at Onizuka AFB, CA		5. FUNDING NUMBERS		
6. AUTHOR(S) S. Hugh Brown				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Pacific Environmental Services, Inc. 13100 Brooks Dr. Baldwin Park, CA 91706		8. PERFORMING ORGANIZATION REPORT NUMBER PES JOB# F028 DISK# 29		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Armstrong Laboratory Occupational and Environmental Health Directorate AL/OEBQ 2402 E Drive, BLDG 175W Brooks AFB, TX 78235-5114		10. SPONSORING/MONITORING AGENCY REPORT NUMBER AL/OE-CR-1994-0017		
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) Sampling was conducted to measure the following contaminant output from one of twelve gas turbines located at the Onizuka AFB Power Plant: NOy, SO ₂ , CO, VOC, PM ₁₀ . The results will be used to determine the banking and selling ² of emission credits upon curtailing of power plant operations.				
14. SUBJECT TERMS Gas turbine generator, emission credits, nitrogen oxides, sulfur dioxide, carbon monoxide, volatile organic compounds, particulate matter			15. NUMBER OF PAGES 127	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL	

GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to **stay within the lines** to meet **optical scanning requirements**.

Block 1. Agency Use Only (Leave blank).

Block 2. Report Date. Full publication date including day, month, and year, if available (e.g. 1 Jan 88). Must cite at least the year.

Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 - 30 Jun 88).

Block 4. Title and Subtitle. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C - Contract	PR - Project
G - Grant	TA - Task
PE - Program Element	WU - Work Unit Accession No.

Block 6. Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

Block 7. Performing Organization Name(s) and Address(es). Self-explanatory.

Block 8. Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

Block 9. Sponsoring/Monitoring Agency Name(s) and Address(es). Self-explanatory.

Block 10. Sponsoring/Monitoring Agency Report Number. (If known)

Block 11. Supplementary Notes. Enter information not included elsewhere such as: Prepared in cooperation with...; Trans. of...; To be published in.... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

Block 12a. Distribution/Availability Statement. Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR).

DOD - See DoDD 5230.24, "Distribution Statements on Technical Documents."

DOE - See authorities.

NASA - See Handbook NHB 2200.2.

NTIS - Leave blank.

Block 12b. Distribution Code.

DOD - Leave blank.

DOE - Enter DOE distribution categories from the Standard Distribution for Unclassified Scientific and Technical Reports.

NASA - Leave blank.

NTIS - Leave blank.

Block 13. Abstract. Include a brief (*Maximum 200 words*) factual summary of the most significant information contained in the report.

Block 14. Subject Terms. Keywords or phrases identifying major subjects in the report.

Block 15. Number of Pages. Enter the total number of pages.

Block 16. Price Code. Enter appropriate price code (*NTIS only*).

Blocks 17. - 19. Security Classifications. Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.

Block 20. Limitation of Abstract. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.

FOREWORD

This report was prepared by Pacific Environmental Services, Inc. (PES) using due and ordinary care and in accordance with the scope of work identified in the Professional Services Agreement, Purchase Order, or other written/verbal request.

Any measured contaminants and their concentrations detected or identified in this study are for the sample(s) obtained or for the observations made at the time(s) and location(s) referenced in the report and may not represent other times, locations, or contaminants and their concentrations.

Except for the tests and observations conducted by PES, no attempt was made to check for compliance of present or past owners or operators of the equipment, plant, or site with federal, state, or local laws and regulations.

The information provided in this report, including any drawings and specifications, was prepared solely for the use of the identified client and any use by any other party shall be at their own risk.

The project work was conducted by Steven M. Hernandez, Robert T. Nguyen, and S. Hugh Brown under the direction of S. Hugh Brown.

Approved:

S. Hugh Brown
S. Hugh Brown, Director
Air Quality Testing

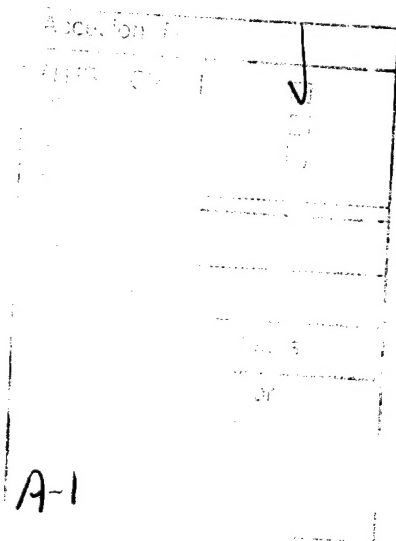


TABLE OF CONTENTS

	<u>Page</u>
CHAPTER 1 INTRODUCTION	1-1
CHAPTER 2 EQUIPMENT AND PROCESS DESCRIPTION	2-1
CHAPTER 3 TESTING METHODOLOGY	3-1
PM10	3-1
Continuous Monitoring	3-4
CHAPTER 4 RESULTS	4-1
PM10	4-1
CHAPTER 5 QUALITY ASSURANCE/QUALITY CONTROL	5-1
Use Of Standard Test Procedures	5-1
Use Of Trained Test Personnel	5-1
Knowledge Of Source's Operation	5-1
Equipment Maintenance And Calibration	5-1
Thorough Record Keeping	5-2
Use Of Thoroughly Cleaned Glassware	5-2
Use Of Standardized Data Reduction Techniques	5-2
Submission Of Blank Samples	5-3
APPENDIX A EQUIPMENT PERMITS	
APPENDIX B FIELD DATA AND CALCULATION SHEETS	
APPENDIX C LABORATORY REPORT AND VOC ANALYTICAL METHOD	
APPENDIX D CALIBRATION DATA	

LIST OF TABLES

<u>Table</u>	<u>Page</u>
3.1 Continuous Monitoring Specifications	3-5
3.2 Calibration Gases	3-7
4.1 Turbine Number 2 Exhaust - PM10 Continuous Emission Monitoring . . .	4-2
4.2 Turbine Number 2 Exhaust - Hydrocarbon Emissions	4-5
4.3 Turbine Number 2 Exhaust - Sulfur Dioxide Emission Factor	4-6

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
2.1 Plant Layout and Equipment Location	2-2
2.2 Schematic - Turbine/Heat Recovery Boiler Number 2	2-3
3.1 Sampling Location - Turbine Number 2	3-2
3.2 PM10 Sampling Train - EPA Method 201A	3-3
3.3 Continuous Monitoring Train - CARB Method 100	3-8
3.4 VOC Sampling Train	3-10

CHAPTER 1

INTRODUCTION

Onizuka Air Force Base currently has twelve gas turbine generators which supply electric power for the entire facility. Heat recovery boilers are connected to each generator. Current plans are for the power plant to curtail its operation. Under current Bay Area Air Quality Management District (BAAQMD) rules and regulations, emissions credits can be banked and sold. Source testing is required to quantify the baseline emissions for each constituent potentially reduced.

Based on information obtained from the BAAQMD, source testing was conducted for nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOC), and particulate matter less than 10 microns (PM_{10}).

Pacific Environmental Services (PES), a participant in CARB's Independent Contractor Program, was hired by the Air Force to perform the required source testing and data reduction. PES qualifies as an independent testing laboratory (no conflict of interest). The source testing was conducted by S. Hugh Brown, Steven Hernandez, and Robert Nguyen of PES on December 3, 1993 and January 12, 1994.

CHAPTER 2

EQUIPMENT AND PROCESS DESCRIPTION

All of the gas turbine generators were identical 750 kVA units that were manufactured by Solar and each consumed a maximum of 130 therms/hour of natural gas. Gas turbine #2 was equipped with sampling ports and a work platform and was used as a demonstration unit for all twelve generators. The turbine exhaust gases were routed under the turbine platform and over to the heat recovery boiler adjacent to the turbine on the same platform. The gases entered the boiler through a diverter/bypass damper at the base of the exhaust stack. When the damper was in the bypass position, the gases were routed straight up the stack to atmosphere. When the damper was in the closed position, the gases were routed horizontally through the boiler exiting the top and rejoining the stack just above the bypass damper. The location of the turbines on the base is shown in Figure 2.1. The gas turbine and heat recovery boiler are depicted in Figure 2.2. A copy of the Permit to Operate issued by the BAAQMD is located in Appendix A.

The source testing was conducted on gas turbine #2 at a constant load of about 570 KW with the heat recovery boiler damper set at 75% closed (25% bypass).

Figure 2.1
Plant Layout And Equipment Location

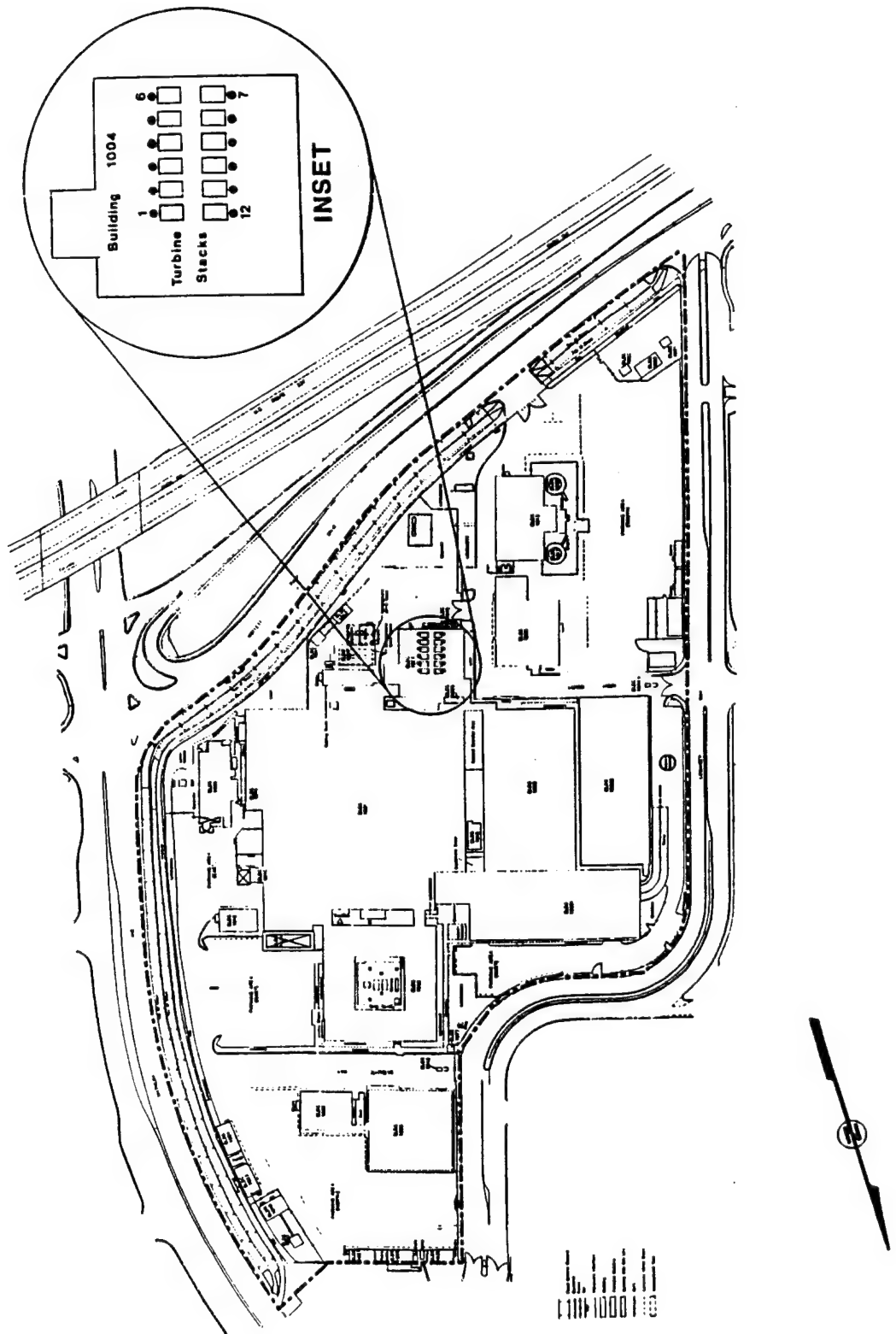
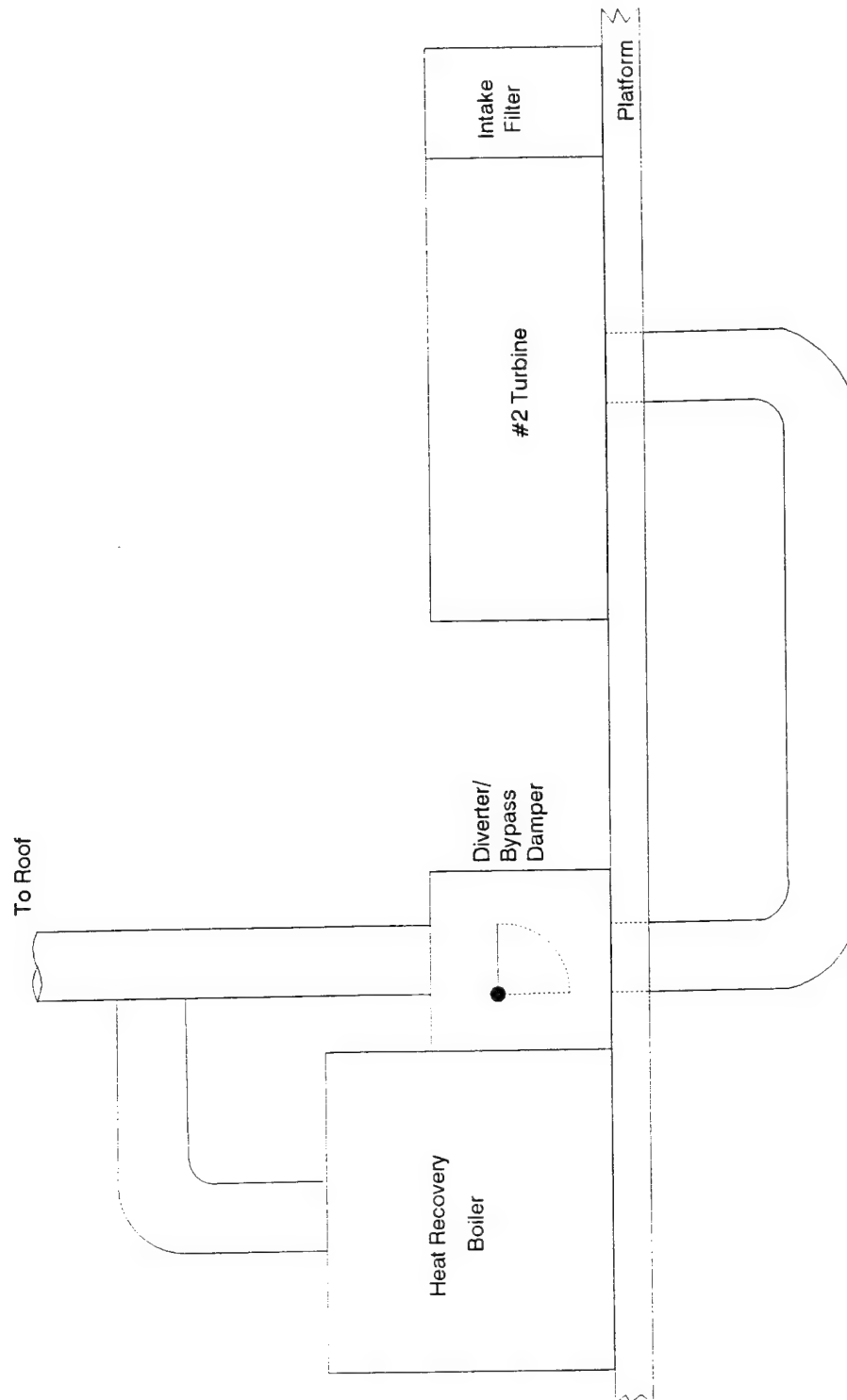


Figure 2.2
Schematic - Turbine/Heat Recovery Boiler Number 2



CHAPTER 3

TESTING METHODOLOGY

The approximate sampling port locations are shown on Figure 3.1. The number of traverse points required (4 on each of two diameters, 90 degrees apart) and their locations were derived from CARB Method 1. The sampling was conducted on the exhaust of turbine #2 at roof level during block load conditions. Triplicate tests were conducted for each constituent determined.

PM10

The PM10 emissions of the exhaust were determined by EPA Method 201A. The sampling train is shown in Figure 3.2 and consisted of a stainless steel nozzle, a 10-micron cut-off cyclone and an in-stack stainless steel filter holder manufactured by Andersen, a 48-inch glass probe, a 10-foot Teflon hose from the probe to the first impinger, two Greenburg-Smith impingers each charged with 100 mls of distilled water, an empty impinger, an impinger filled with silica gel, a 30-foot umbilical line, a vacuum pump, a dry gas meter and a calibrated orifice connected to an oil inclined manometer. Glass fiber filters were used in the filter holders. Each sample was collected isokinetically at a fixed sampling rate and the number of minutes sampled at each traverse point was determined by the ratio of the point velocity to the average velocity. The velocity and temperature were measured at each traverse point as it was sampled. Field data and calculation sheets are included in Appendix B.

The volume of the impinger solution and the weight of the silica gel were recorded before and after the tests in order to obtain the moisture content of the stack gas stream. All sample volumes and weights were recorded immediately on sample recovery sheets (Appendix B) during charging and sample recovery. Leak checks were performed before and after each test. The post-test leak check was performed after removing the cut-off cyclone so as not to disturb the particle catch.

After the test, the contents of the nozzle and cut-off cyclone (PM10+) were recovered by rinsing three times with acetone. The washings were placed in a 125-milliliter polyethylene container. The filter was placed in a plastic cassette. The contents of the cyclone exit and filter holder front (PM10) were also recovered by rinsing three times with acetone. The washings were placed in a separate 125-milliliter polyethylene container. The contents of each impinger set was placed in a 1000-milliliter polyethylene container. The sampling train was then rinsed from the 3rd impinger to the nozzle with the distilled water and the rinse was added to the sample. The impinger solution was saved but not analyzed. Disposable vinyl gloves were worn during sample retrieval to help prevent contamination.

Figure 3.1
Sampling Location - Turbine Number 2

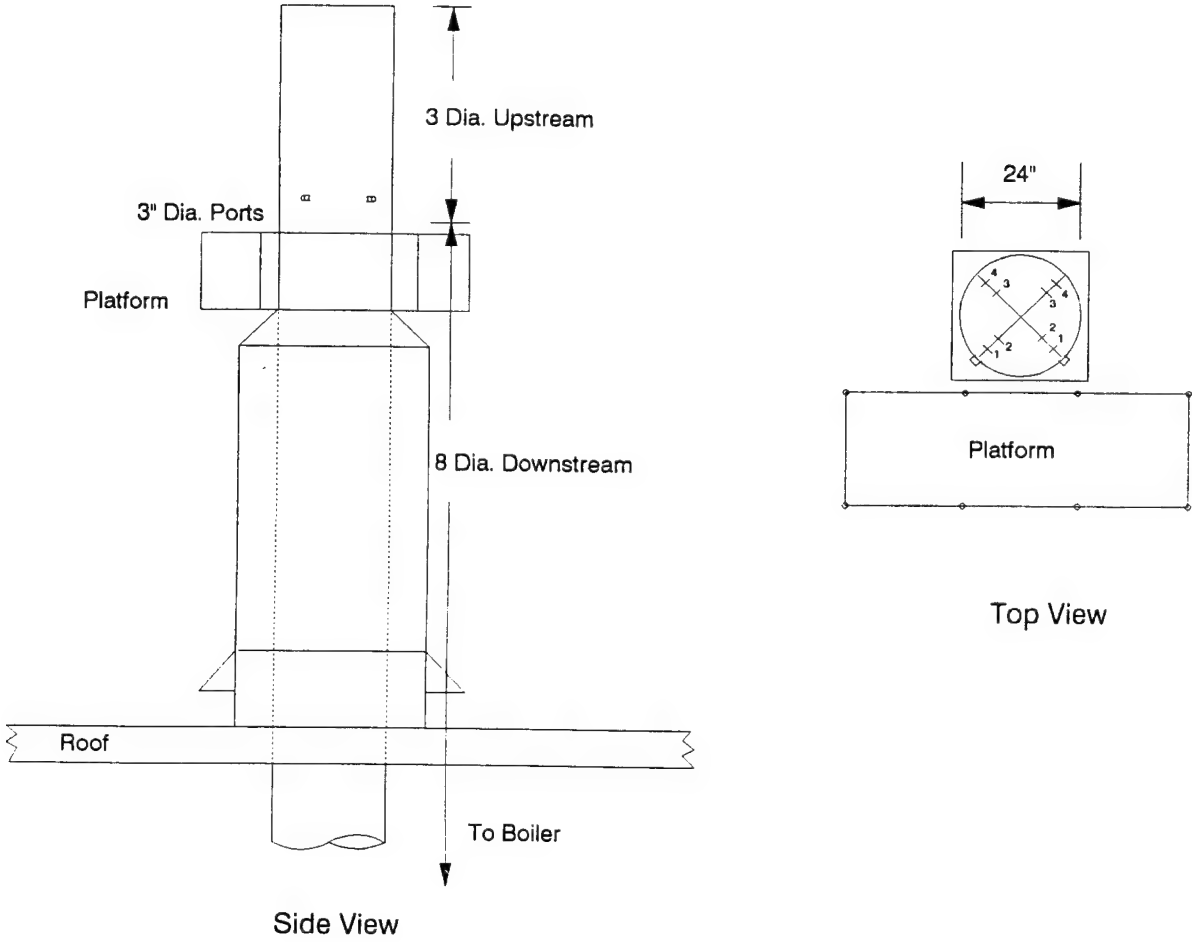
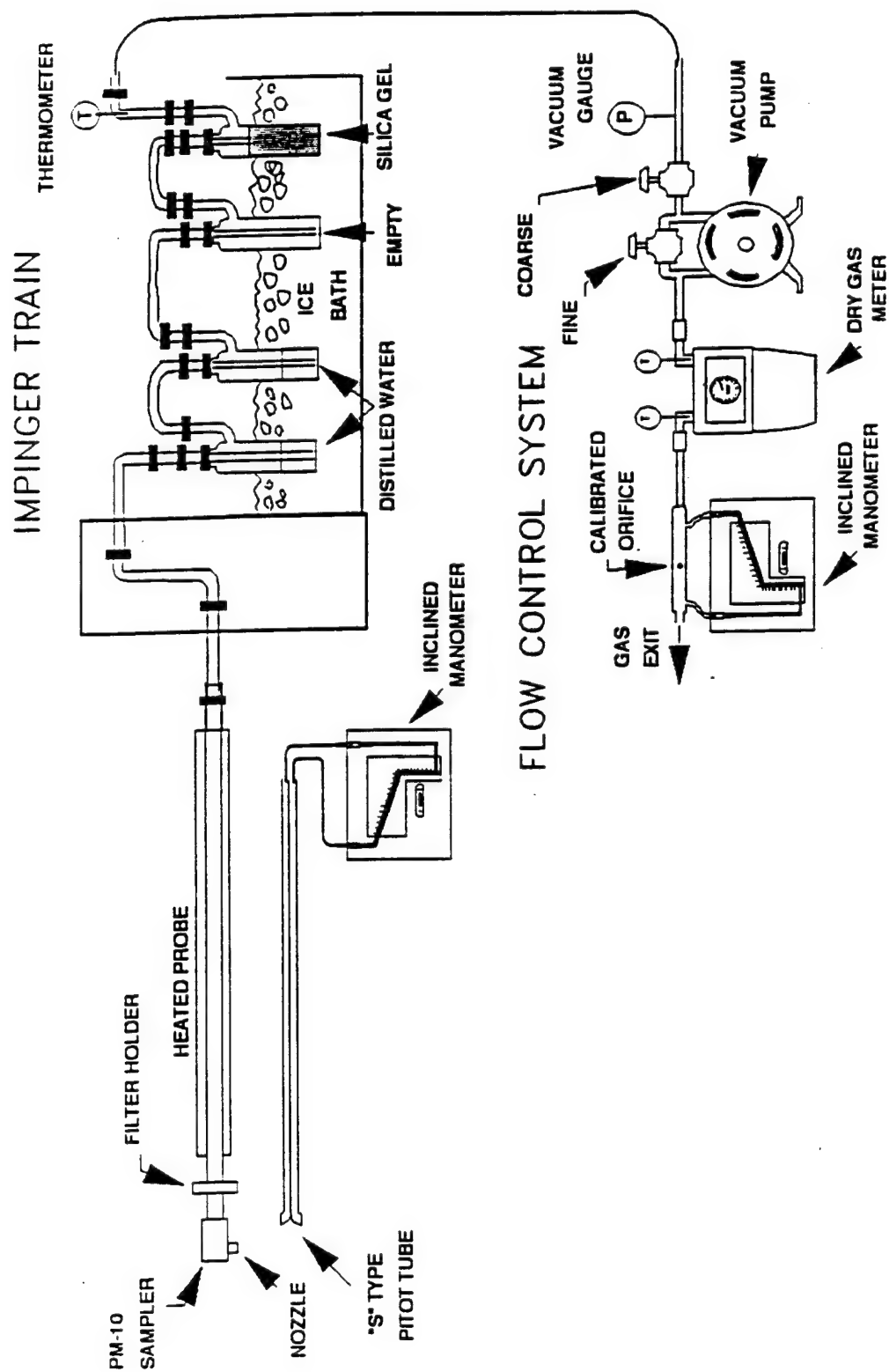


Figure 3.2
PM10 Sampling Train - EPA Method 201A



The particulate fractions were evaporated to dryness at 100 degrees Centigrade and desiccated to a constant weight along with the sample filter.

CONTINUOUS MONITORING

The turbine/boiler exhaust was monitored for VOC, CO, CO₂, O₂ and NO_x by CARB Method 100. Each test run was 60 minutes long. Rosemount Analytical Model 880 Infrared Analyzers were used to determine the CO and CO₂ concentrations. A Rosemount Analytical Model 755R Paramagnetic Analyzer was used to determine the oxygen concentration, and a Thermo Electron Model 10 Chemiluminescent Analyzer was used to determine the NO_x concentration. The output of the analyzers was linearized by the manufacturers. Table 3.1 lists the instrument specifications. Table 3.2 lists the calibration gases that were used specific to this job.

The continuous monitoring train for the above gases is shown in Figure 3.3 and consisted of a 3/8-inch stainless steel sampling probe, a 3/8-inch heated Teflon sampling line, a sample refrigeration/pump system, a glass fiber filter in a 47-millimeter stainless steel holder, and a sample distribution manifold. The distribution manifold was equipped with a series of 3-way valves with flow meters (rotometer style). One flow meter acted as a bypass, and the others were connected to the individual analyzers. The output of the analyzers was logged by a Yokogawa Model HR2400 multi-channel recorder and a Rustrak Ranger II data logger.

The NO_x analyzer was operated on a range of 0-50 ppmv with span gases at 10.4, 23.5, and 44.2 ppmv. The CO analyzer was operated on a range of 0-100 ppmv with span gases at 50 and 75 ppmv. The O₂ analyzer was operated on a range of 0-25 per cent with span gases at 11.0 and 19.0 per cent. The CO₂ analyzer was operated on a range of 0-5 per cent with span gases at about 2.0 and 4.0 per cent. Prior to the source tests, the suction side of the monitoring system was leak-checked at a full vacuum (greater than 20 inches mercury).

A bias check was made on each analyzer by comparing the response between the span gas introduced at the sample line tip and the span gas introduced directly to the analyzer to ensure a differential of less than 5 per cent. The analyzers were spanned before and after each test run with NIST traceable calibration gases from Scott Specialty, and with zero grade nitrogen.

The total hydrocarbons were determined on January 12, 1994 by using a JUM Model VE-7 total hydrocarbon analyzer that utilized a heated Teflon sample line and a flame ionization detector mounted in a heated oven. The sample line was maintained at 250 degrees Fahrenheit, and the oven was maintained at 180 degrees Centigrade. Since the gas stream was expected to have a low concentration of

Table 3.1
Continuous Monitoring Specifications

NO _x Chemiluminescent Analyzer - Thermo-Electron Model 10A	
Response Time	1.5 sec - NO, 1.7 sec - NO _x
Zero Drift	± 0.5 % after warm up (30 min)
Span Drift	± 1 % of full scale
Linearity	± 1 % of full scale
Accuracy	Derived from the calibration NO/NO _x ± 1 % gas was used.
Output	NO 0-5.0 Vdc (scaled 0-50 ppm) NO _x 0-0.5 Vdc (scaled 0-50 ppm)
O ₂ Paramagnetic Analyzer - Beckman Model 755R	
Response Time	2 Sec
Zero Drift	± 1 % of full scale
Span Drift	± 1 % of full scale
Linearity	± 1 % of full scale
Accuracy	Derived from the calibration O ₂ ± 1 % gas was used.
Output	0-1.0 Vdc (scaled 0-25 %)
CO/CO ₂ Infrared Analyzers - Beckman Model 880	
Response Time	2 sec
Zero Drift	± 1 % of full scale
Span Drift	± 1 % of full scale
Linearity	± 1 % of full scale
Accuracy	Derived from the calibration CO ± 1 % gas was used.
Output	0-1.0 Vdc (scaled 0-100 ppm CO) 0-1.0 Vdc (scaled 0-20 % CO ₂)

Table 3.1 - Continued

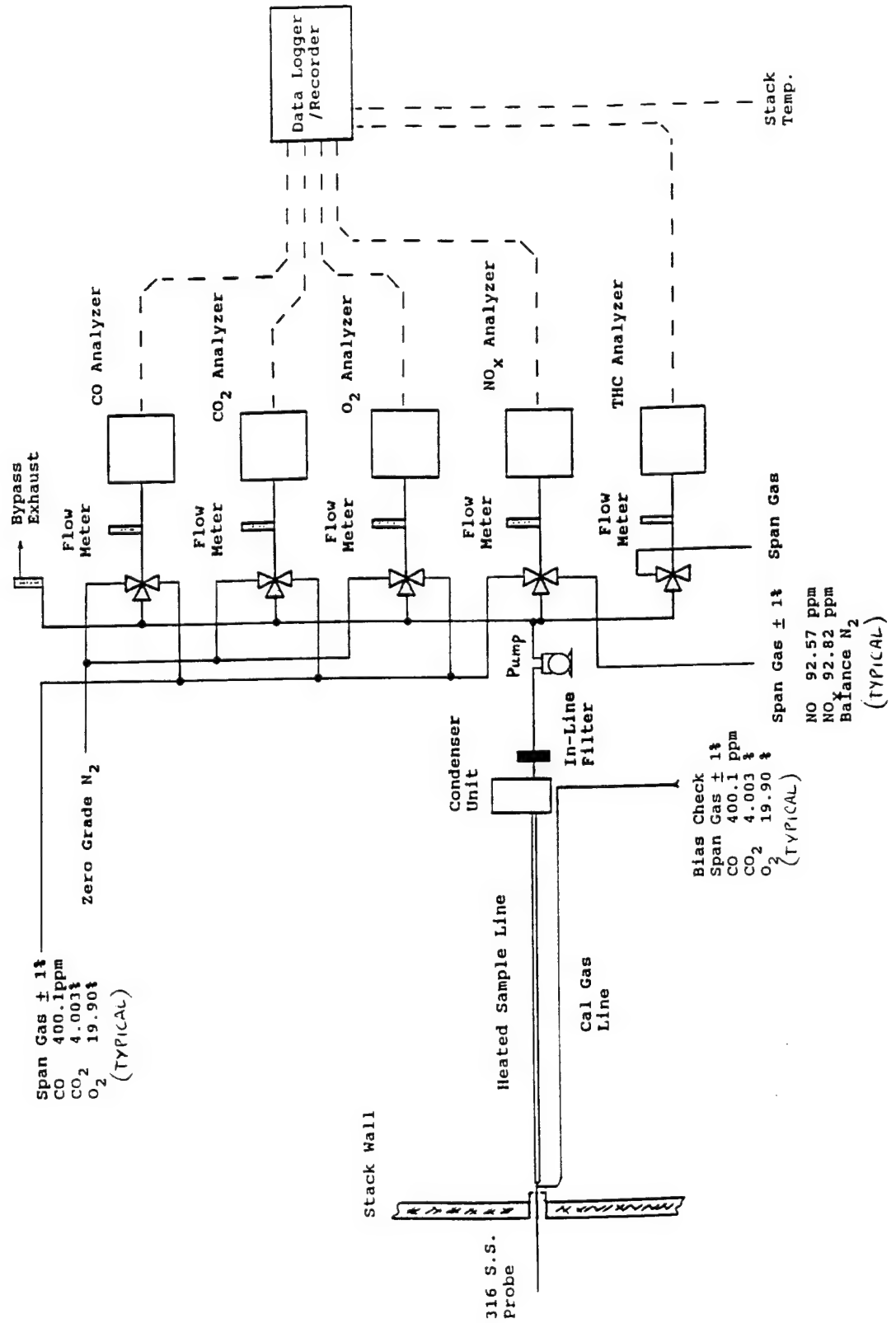
VOC Heated Hydrocarbon Analyzer - J.U.M. Engineering Model VE-7 FID Analyzer			
Response Time	0-95 % in less than 1.2 Seconds		
Zero Drift	$\pm 1\%$ of Full Scale in 24 Hrs		
Span Drift	$\pm 1\%$ of Full scale in 24 Hrs		
Linearity	$\pm 1\%$ of Full Scale		
Accuracy	Derived from the Calibration Gas $\pm 1\%$ gas was used		
Sensitivity	1 ppb		
Range Change Consistency	Less than 1% Full Scale		
Oxygen Synergism	Less than 2%		
Output	0-10.0 Vdc Scaled:		
	R ₁	0-10	ppm as C ₃
	R ₂	0-100	ppm as C ₃
	R ₃	0-1,000	ppm as C ₃
	R ₄	0-10,000	ppm as C ₃
	R ₅	0-100,000	ppm as C ₃
Sample Flow Rate	3 Liters/Minute		

Table 3.2
Calibration Gases

Gas Composition	Use	Cylinder Ser. / No.	Certified Accuracy	Analysis Date
Nitrogen	Zero Gas	AAL / 4542	Zero Grade	N/A
11.0% O ₂ 50.0 ppmv CO 11.0% CO ₂ Bal N ₂	Span Gas	1L / 2572	$\pm 1\%$ $\pm 1\%$ $\pm 1\%$	04/08/93
19.0% O ₂ 75.0 ppm CO 18% CO ₂ Bal N ₂	Span Gas	ALMO / 04292	$\pm 1\%$	04/29/93
10.36 ppm NO 10.39 ppm NO _x Bal N ₂	Span Gas	ALM / 010841	$\pm 1\%^*$	12/02/93 exp 12/95
22.90 ppm NO 23.46 ppm NO _x Bal N ₂	Span Gas	ALM / 034155	$\pm 1\%^*$	10/06/93 exp 10/95
43.83 ppm NO 44.17 ppm NO _x Bal N ₂	Span Gas	ALM / 027046	$\pm 1\%^*$	12/23/93 exp 12/95
2.0% CO	Span Gas	ALM / 008830	$\pm 1\%^*$	09/17/93
4.0 CO	Span Gas	ALM / 033923	$\pm 1\%^*$	09/16/93

* EPA Protocol 1 gas.

Figure 3.3
Continuous Monitoring Train - CARB Method 100



hydrocarbons, the instrument was used on a 0-50 ppmv range and standardized with 20 and 40 ppmv propane calibration gases. Each test run was about 50 minutes long.

In order to determine the methane concentration of the stack gas for correcting the total hydrocarbon monitoring data and as a back-up total hydrocarbon analysis, an integrated sample of the flue gas was collected for about 40 minutes concurrently with each monitoring run by using EPA Method 25 modified to eliminate the condensate trap. The sampling train is shown in Figure 3.4 and consisted of a stainless steel sampling probe connected through a flow control device (micro orifice disc meter) to an evacuated 12-liter stainless steel cylinder. The orifice meter reading and the cylinder gage vacuum were recorded at 10-minute intervals during the sampling period on field data sheets (see Appendix B).

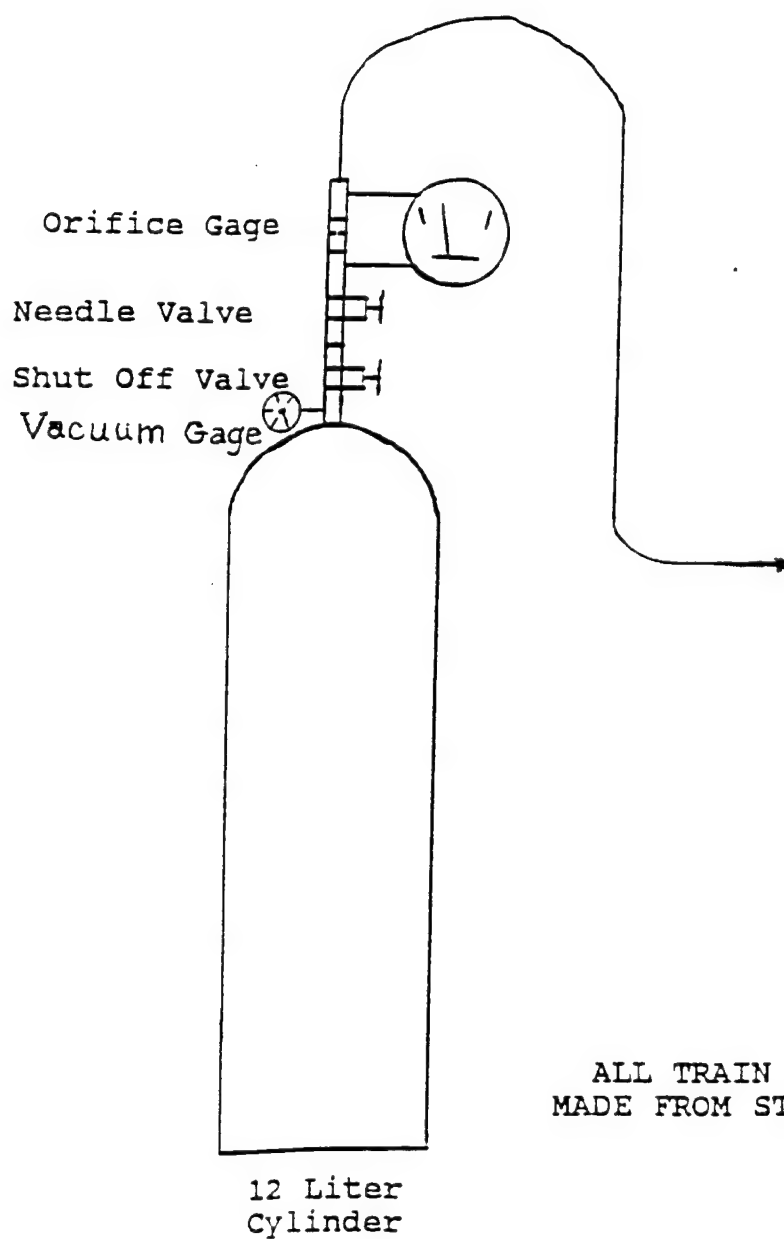
The integrated samples were analyzed for carbon monoxide (CO), methane (CH₄), carbon dioxide (CO₂), oxygen (O₂), and nonmethane hydrocarbons (as C₁) by Truesdail Laboratories, in Tustin, CA according to EPA Method 25. A sample submittal/chain of custody sheet was completed and is included in Appendix B along with the field data and calculation sheets. The analytical procedures performed at Truesdail are detailed in Appendix C along with the laboratory report.

Emission factors for the gases were calculated based on the natural gas usage. A mass balance calculation was performed on the entire power plant. The natural gas usage of all turbines is routed through a gas meter. The gas usage was monitored for first test day and related to the number of turbines operating and the kilowatt load for each.

Sulfur Dioxide

Sulfur dioxide emissions were expected to be very low. Since the source of sulfur is the odorant in the natural gas, the sulfur dioxide emissions were reported in pounds per therm (100 CF of natural gas) by using the sulfur content of the fuel (from the gas supplier).

Figure 3.4
VOC Sampling Train



NOTE: Samples usually collected in
duplicate or triplicate concurrently

CHAPTER 4

RESULTS

Calculations were made from the field data sheets and lab analyses to determine sample volume, molecular weight, velocities, flow rates, component concentrations, and micron cut-off size for the tests.

PM10

Analyses of PM10 emissions for each test run on the turbine included determinations for total solid particulate matter (PM). Condensables were not included in the PM10 results. Although some weight was recorded for each PM10 fraction, 1 milligram was chosen as a level of significance in order to account for fluctuations in the balance weights and for minute amounts of grease contamination from the threads of the PM10 sampling head. Results of the tests are summarized in Table 4.1. No significant PM10 or particulate matter was detected.

Gases

The nitrogen oxide and carbon monoxide emissions were 3.1 and 3.5 pounds per hour, respectively. The emission factors were reported as pounds per therm (100 CF) as indicated on the natural gas meter supplying the power plant. The gas meter had two indicators: one mechanical and one digital. The larger volume reading (digital) was assumed to be the corrected reading and this value was used for all of the emission factors calculations. However, this reading appears to have some unknown multiplier because the therm usage is too low for the known consumption of the gas turbines. For the purposes of calculating any periodic emissions, the emission factors should be used against the digital reading as indicated at the gas meter. Results are reported in Table 4.1.

The continuous monitoring for total hydrocarbons was unexpectedly variable and high (10 to 35 ppmv as C₃) and indicated that the sample line, although heated, was contaminated from previous testing which involved very heavy organics. As a back-up, the integrated sample cylinders that were sampled concurrently and analyzed for methane were also analyzed for total nonmethane hydrocarbons and the resulting average value (5 ppmv) was used to calculate the VOC emission factor. Results are reported in Table 4.2.

The sulfur dioxide emission factor was calculated from information supplied by PG&E in San Francisco, CA which supplies the natural gas to the base. The sulfur dioxide emission factor used by PG&E is 0.001 pounds per million BTU which

Table 4.1
Turbine Number 2 Exhaust - PM10 Continuous Emission Monitoring

Description	Run #1	Run #2	Run #3	Average
Sampling Date	12/03/93	12/03/93	12/03/93	
Sample Number	OAFB-1	OAFB-2	OAFB-3	
Turbine Load, KW	570	570	558	
Waste Heat Damper, %	75	75	75	
Gas Usage, therms/hr	12.4*	12.4*	12.2*	
<u>Flue Gas</u>				
Temperature, °F	450	457	460	
Velocity, ft/sec	117.4	117.1	115.8	
Flow Rate, ACFM	22,120	22,060	21,820	
Flow Rate, DSCFM	12,300	12,200	12,030	
Moisture, % v/v	4.7	4.5	4.5	
<u>PM10</u>				
Sample Start	07:19	10:30	13:54	
Sample Stop	09:22	12:29	15:51	
Sampling Time, min	116.1	115.2	113.7	
Sample volume, DSCF	90.1	90.3	89.1	
Cutoff, microns	10.0	10.0	10.0	
Collection, g	<0.001	<0.001	<0.001	<0.0002
Concentration, g/DSCF	<0.0002	<0.0002	<0.0002	<0.02
Emissions, lbs/hr	<0.02	<0.02	<0.02	<0.002
Factor, lbs/therm	<0.002*	<0.002*	<0.002*	
<u>Total PM</u>				
Collection, g	<0.001	<0.001	<0.001	
Concentration, g/DSCF	<0.0004	<0.0004	<0.0004	<0.0004
Emissions, lbs/hr	<0.04	<0.04	<0.04	<0.04

Table 4.1 - Continued

Description	Run #1	Run #2	Run #3	Average
<u>Continuous Monitoring - Gases</u>				
Sample Start	09:56	11:51	13:46	
Sample Stop	10:56	12:51	14:46	
Concentration, % v/v				
Carbon Dioxide	2.1	2.2	2.2	2.2
Oxygen	17.6	17.5	17.5	17.5
Concentration, ppmv				
Nitrogen Oxides	34	36	37	36
Carbon Monoxide	66	66	66	66
Emissions, lbs/hr				
Nitrogen Oxides	3.0	3.1	3.1	3.1
Carbon Monoxide	3.5	3.5	3.5	3.5
Factor, lbs/therm				
Nitrogen Oxides	0.24*	0.25*	0.25*	0.25*
Carbon Monoxide	0.28*	0.28*	0.29*	0.28*

* Therms as indicated on digital readout of gas meter - appears to have some unknown multiplier.

Table 4.2
Turbine Number 2 Exhaust - Hydrocarbon Emissions

Description	Run #1	Run #2	Run #3	Average
Sampling Date	01/12/94	01/12/94	01/12/94	
Turbine Load, KW	550	550	550	
Waste Heat Damper, %	75	75	75	
Gas Usage, therms/hr	12.0*	12.0*	12.0*	
<u>Flue Gas</u>				
Temperature, °F	441	444	445	
Velocity, ft/sec	103.2	103.2	103.2	
Flow Rate, ACFM	19,450	19,450	19,450	
Flow Rate, DSCFM	10,930	10,930	10,930	
Moisture, % v/v	4.6**	4.6**	4.6**	
<u>Hydrocarbon Samples</u>				
Sample Start	10:56	12:18	13:38	
Sample Stop	11:36	12:58	14:18	
Sampling Time, min	40	40	40	
Concentration, % v/v				18.1
Oxygen (O ₂)	17.9	18.2	18.1	
Concentration, ppmv C ₁				18,630
Carbon Dioxide (CO ₂)	18,610	18,590	18,700	58
Carbon Monoxide (CO)	60	58	57	6
Methane (CH ₄)	7	6	6	5
Total HC (w/o CH ₄)	<4	11	<4	
Emission Rate, lbs/hr C ₁				0.1
Total HC (w/o CH ₄)	<0.04	0.22	<0.04	
Emissions Factor, lbs/therm				
Total HC (w/o CH ₄)	<0.003*	0.018*	<0.003*	

* Therms as indicated on digital readout of gas meter - appears to have some unknown multiplier.

* From PM10 testing - 12/3/93.

is equivalent to a concentration of 6 ppmv in the natural gas as hydrogen sulfide (H₂S). Results are reported in Table 4.3.

Table 4.3
Turbine Number 2 Exhaust - Sulfur Dioxide Emission Factor

<u>Sulfur Dioxide</u> Emission Factor, lbs/therm	0.0001*
---	---------

* Based on standard emission factor used by gas supplier (PG&E).

CHAPTER 5

QUALITY ASSURANCE/QUALITY CONTROL

Source tests are performed to determine the types and amounts of pollutants emitted by a source. Information from this source test program may be used for obtaining permits, evaluating control equipment performance, updating emission inventories, and determining compliance with present and future emission regulations. For these purposes, reliable data are required. PES provides this reliability by using the following work practices:

USE OF STANDARD TEST PROCEDURES

CARB Methods 1 and 2 were utilized to measure flow rates. EPA Method 201A was used to determine the PM₁₀ emission rate, and CARB Method 100 was used to determine the continuous emission rates for the gases. A procedure must be thoroughly studied under various conditions in order to be designated as a state or federal Method. Results of many executions of the procedure are compared to demonstrate accuracy and repeatability before adoption of the procedure as a source testing method.

USE OF TRAINED TEST PERSONNEL

Because of the complexity of typical source testing methods, testers should be trained and experienced with the test procedures in order to assure reliable results. PES personnel have had professional training and routinely conduct source tests.

KNOWLEDGE OF SOURCE'S OPERATION

The source testing team should have sufficient knowledge of the process to be tested in order to properly document the process parameters during the tests. Without documentation of the process parameters used, results are much less meaningful. PES has previously tested boilers and combustion sources and is familiar with the processes and equipment.

EQUIPMENT MAINTENANCE AND CALIBRATION

Use of properly maintained and calibrated test equipment is essential for minimizing systematic errors in results. All sampling devices were constructed,

maintained, and calibrated as suggested in EPA documents APTD-0576, and APTD-0581 (These are commonly accepted construction and maintenance manuals for source testing equipment). The dry gas meters were calibrated with a transfer gas meter with NBS traceability. These calibrations are included in Appendix D along with those for the nozzles, thermocouples, digital potentiometers, and Pitot tubes.

Quality control procedures used for continuous monitoring included the use of non-reactive 316 stainless steel or Teflon tubing and fittings throughout the system. A refrigeration unit was used with the pump down stream of the conditioned sample gas. All instrumentation was continuously monitored and checked between load conditions to insure data reliability during all sample runs. Bias checks were made with a calibration gas blend to confirm they met the tolerances specified in CARB Method 100.

All calibration gases were ± 1 per cent accuracy and provided by Scott Specialty Gases in San Bernardino, California. Copies of the calibration gas certifications are provided in Appendix D.

THOROUGH RECORD KEEPING

All data relating to the operation of the sampling train must be immediately recorded to ensure that it is not lost or misinterpreted. PES accomplishes this thorough record keeping by use of the field data sheets shown in Appendix B. The PES test team is familiar with these sheets and the information required to complete them. Any unusual occurrences in the process operation, unusual test instrument readings, or any other items that could affect the test results was also noted.

USE OF THOROUGHLY CLEANED GLASSWARE

All glassware and probe lines were cleaned prior to the tests with hot tap water and then with 40 per cent nitric acid solution. The trains were then cleaned with 0.1 Normal sodium hydroxide solution, laboratory grade distilled water, air dried, and sealed until the tests.

USE OF STANDARDIZED DATA REDUCTION TECHNIQUES

Data reduction was accomplished by the use of step by step calculation sheets. The calculations were systematic and easy to follow. All calculations for the source test are included in Appendix B.

SUBMISSION OF BLANK SAMPLES

Filter and reagent samples from an unused but charged PM10 sampling train carried to the field was analyzed with the other samples to detect any possible contamination of sampling media or problems with lab analyses. No corrections were made to the measured concentrations of the collected samples, but the blank train results were reported on the calculation sheets.

APPENDIX A
EQUIPMENT PERMITS

**BAY AREA AIR QUALITY
MANAGEMENT DISTRICT**939 ELLIS STREET
SAN FRANCISCO, CALIFORNIA 94109
(415) 771-6000**PERMIT**
TO

Plant# 232

Page 1

Expires: JUL 1, 1993

This document does not permit the holder to violate any District regulation or other law

Gerald Reid
Onizuka Air Force Base
P O Box 3430
Sunnyvale, CA 94088ORIGINAL SENT TO:
Onizuka Air Force Base
1080 Lockheed Way
Sunnyvale, CA 94088

S#	DESCRIPTION	[Schedule]	PAID
1	Turbine - Cogeneration, 12750K BTU/hr max, Multifuel GAS TURBINE ENGINE WITH WASTE HEAT BOILER NO. 1 Emissions at: P1 Stack	[B]	150
2	Turbine - Cogeneration, 12750K BTU/hr max, Multifuel GAS TURBINE ENGINE WITH WASTE HEAT BOILER NO. 2 Emissions at: P2 Stack	[B]	150
3	Turbine - Cogeneration, 12750K BTU/hr max, Multifuel GAS TURBINE ENGINE WITH WASTE HEAT BOILER NO. 3 Emissions at: P3 Stack	[B]	150
4	Turbine - Cogeneration, 12750K BTU/hr max, Multifuel GAS TURBINE ENGINE WITH WASTE HEAT BOILER NO. 4 Emissions at: P4 Stack	[B]	150
5	Turbine - Cogeneration, 12750K BTU/hr max, Multifuel GAS TURBINE ENGINE WITH WASTE HEAT BOILER NO. 5 Emissions at: P5 Stack	[B]	150
6	Turbine - Cogeneration, 12750K BTU/hr max, Multifuel GAS TURBINE ENGINE WITH WASTE HEAT BOILER NO. 6 Emissions at: P6 Stack	[B]	150
7	Turbine - Cogeneration, 12750K BTU/hr max, Multifuel GAS TURBINE ENGINE WITH WASTE HEAT BOILER NO. 7 Emissions at: P7 Stack	[B]	150
8	Turbine - Cogeneration, 12750K BTU/hr max, Multifuel GAS TURBINE ENGINE WITH WASTE HEAT BOILER NO. 8 Emissions at: P8 Stack	[B]	150
9	Turbine - Cogeneration, 12750K BTU/hr max, Multifuel GAS TURBINE ENGINE WITH WASTE HEAT BOILER NO. 9 Emissions at: P9 Stack	[B]	150

APPENDIX B
FIELD DATA AND CALCULATION SHEETS

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

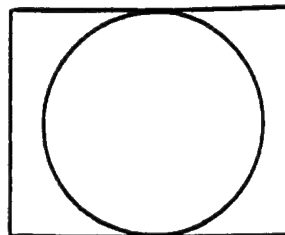
ONIZUKA AFB
 PLANT _____
 DATE 12-2-43
 SAMPLING LOCATION TURBINE # 2
 INSIDE OF FAR WALL TO 25"
 OUTSIDE OF NIPPLE. (DISTANCE A)
 INSIDE OF NEAR WALL TO 1"
 OUTSIDE OF NIPPLE. (DISTANCE B)
 STACK I.D., (DISTANCE A - DISTANCE B) 24"
 NEAREST UPSTREAM DISTURBANCE 3' Ø
 NEAREST DOWNSTREAM DISTURBANCE 2' + Ø
 CALCULATOR SHB

SCHEMATIC OF SAMPLING LOCATION

[illegible]

PRELIMINARY VELOCITY TRAVERSE

Plant: ONIZUKA AFB
Date: 12-2-93
Location: TURBINE #2
Stack I.D.: 24"
Barometric Pressure, in. Hg: 30.3
Stack Gauge Pressure, in. H₂O: _____
Operators: BROWN / LEARNEY
Pitot Tube I.D. Number: S17A
Temperature Readout I.D.: BOX 3A
Pitot Tube Leak Check: OK



Sampling
Location



Schematic of Traverse Point Layout

Traverse Point Number	Velocity Head (Δp_s) in. H ₂ O	Stack Temp. (T _a), °F	Cyclonic Flow Check ° from Null
1-4	2.7	673	
Average			

Traverse Point Number	Velocity Head (ΔP_g) in. H ₂ O	Stack Temp. (T _s), °F	Cyclonic Flow Check ° from Null
Average			



SAMPLE RETRIEVAL DATA

Plant: ONIZUKA AFB
Date: 12-3-93
Sampling Location: TURBINE #2 STACK
Sampling Type (Method): PM-10
Run Number: ~~3B~~ 0AFB-1
Sample Box Number: 3B
Clean-up Man: BROWN KEARNEY
Job Number: F028
Comments: _____

Filter

Filter Number: _____
Description of Filter: CLEAN _____

Moisture

	#1	#2	#3
Impingers:			
Final Volume:	<u>157.0</u> mL	<u>102.0</u> mL	<u>16.0</u> mL
Initial Volume:	<u>100.0</u> mL	<u>100.0</u> mL	<u>0.0</u> mL
Net Volume:	<u>57.0</u> mL	<u>2.0</u> mL	<u>16.0</u> mL
Total H ₂ O:	<u>57</u> mL	<u>59</u> mL	<u>75</u> mL

Silica Gel

Final Volume:	<u>700.9</u> g	_____ g	_____ g
Initial Volume:	<u>681.9</u> g	_____ g	_____ g
Net Volume:	<u>19.0</u> g	_____ g	_____ g
Total Moisture:	<u>94</u> g	_____ g	_____ g

Description of Impinger catch: CLEAR

Plant: ONIZUKA AFB

Date: 12-3-93

Source/Sample Number: OAFB-1

$$1. Vm(std) = (17.64)(Vm)(Y) \left[\frac{P_{bar} + (\Delta H/13.6)}{Tm} \right]$$

$$Vm(std) = (17.64)(89.879)(0.99) \left[\frac{(30.2) + (2.15/13.6)}{(529)} \right]$$

$$Vm(std) = \underline{90.1} \text{ dscf.}$$

2. Volume water vapor collected (standard conditions).

$$V(1o) = \underline{94} \text{ condensate from impingers and silica gel.}$$

$$Vw(std) = (0.04707) V(1o) = (0.04707)(94)$$

$$Vw(std) = \underline{4.42} \text{ scf.}$$

3. Percent moisture, by volume.

$$Bw_s = \frac{Vw(std)}{Vw(std) + Vm(std)} = \frac{(4.42)}{(4.42) + (90.1)} = \underline{0.047}$$

$$Bw_s = \underline{4.7\%}.$$

4. Molecular weight, stack gas.

Dry molecular weight.

$$Md = 0.440(\% CO_2) + 0.320(\% O_2) + 0.280(\% N_2 + \% CO)$$

$$Md = 0.440(2.5) + 0.320(17.5) + 0.280(80)$$

$$Md = \underline{29.1} \text{ lb/lb-mole.}$$

$$Ms = Md + Bw_s (18 - Md) = (29.1) + (0.047)(18 - 29.1)$$

$$Ms = \underline{28.58} \text{ lb/lb-mole.}$$

Plant: ONIZUKA AFB

Date: 12-3-93

Source/Sample Number: 0AFB-1

5. Stack gas velocity average.

$$V_s(\text{avg}) = (85.49)(C_p)(\sqrt{\Delta P}) \left[\text{avg} \sqrt{\frac{(T_s)}{(P_s)(M_s)}} \right]$$

$$V_s(\text{avg}) = (85.49)(0.84)(1.59) \left[\sqrt{\frac{(910)}{(30.1)(28.58)}} \right]$$

$$V_s(\text{avg}) = \underline{117.4} \text{ ft/sec.}$$

6. Stack volumetric flow rate, actual conditions (stack temperature and pressure).

$$Q_s = (60)(V_s)(A) = (60)(117.4)(3.14)$$

$$Q_s = \underline{22118} \text{ acfm.}$$

7. Stack volumetric flow rate, standard conditions (68 degrees F, 29.92 Hg).

$$Q(\text{std}) = (17.64)(Q_s)(1 - Bw_s) \left[\frac{(P_s)}{(T_s)} \right]$$

$$Q(\text{std}) = (17.64)(22118)(1 - 0.047) \left[\frac{(30.1)}{(910)} \right]$$

$$Q(\text{std}) = \underline{12299} \text{ dscfm.}$$

8. Isokinetic variation.

$$\%I = (K) \left[\frac{(T_s)(V_m(\text{std}))}{(P_s)(V_s)(A_n)(\theta)(1 - Bw_s)} \right]$$

$$\%I = (0.0945) \left[\frac{(\quad)(\quad)(\quad)}{(\quad)(\quad)(\quad)(\quad)(1 - \quad)} \right]$$

$$\%I = \underline{N/A} \%$$

Plant: ONIZUKA AFB

Date: 12-3-73

Source/Sample Number: 0AFB-1

9. Viscosity of stack gas:

$$\mu_s = 152.418 + 0.2552 t_s + 3.2355 \times 10^{-5} (t_s)^2 + \\ 0.53147 (\%O_2) - 74.143 Bw_s$$

$$\mu_s = 152.418 + 0.2552 (450) + 3.2355 \times 10^{-5} (450)^2 + \\ 0.53147 (17.5) - 74.143 (0.047)$$

$$\mu_s = \underline{279.6} \text{ micropoise.}$$

10. Cyclone flow rate:

$$Q_s = 0.002837 \mu_s \left(\frac{t_s + 460}{M_w P_s} \right)^{0.2949}$$

$$Q_s = 0.002837 (279.6) \left(\frac{(450) + 460}{(28.58) (30.1)} \right)^{0.2949}$$

$$Q_s = \underline{0.81} \text{ ft}^3/\text{min}$$

11. Orifice pressure head for cyclone flow rate:

$$\Delta H = \left(\frac{Q_s (1 - Bw_s) P_s}{t_s + 460} \right)^2 \left(\frac{(t_s + 460) M_s (1.083) \Delta H@}{P_{bar}} \right)$$

$$\Delta H = \left(\frac{(0.81) (1 - 0.047) (30.1)}{(450) + 460} \right)^2 \left(\frac{(69 + 460) (29.1) (1.083) (1.916)}{(33.2)} \right)$$

$$\Delta H = \underline{0.69} \text{ in. H}_2\text{O}$$

Plant: ONIZUKA AFB

Date: 12-3-93

Source/Sample Number: OAFB-1

Stack viscosity, μ_s , micropoise = 279.6
Absolute stack pressure, P_s , in. Hg = 30.1
Average stack temperature, t_s , °F = 450
Meter temperature, t_m , °F = 69
Method 201A pitot coefficient, C_p = 0.84
Cyclone flow rate, Q_p , ft³/min, Q_p = 0.81
Method 2 pitot coefficient, C_p = 0.84
Molecular weight of stack gas, wet basis, M_w = 28.58
Nozzle diameter, D_n , in. = 0.150

Nozzle velocity

$$v_n = \frac{3.056 Q_s}{D_n^2} = \underline{110.0} \text{ ft/sec}$$

Maximum and minimum velocities:

Calculate R_{min} .

$$R_{min} = 0.2457 + \left[0.3072 - \frac{0.2603 (\sqrt{Q_s}) \mu_s}{v_n^{1.5}} \right] = \underline{0.75}$$

If R_{min} is less than 0.5, or if an imaginary number occurs when calculating R_{min} , use Equation 1 to calculate v_{min} . Otherwise, use Equation 2.

Eq. 1 $v_{min} = v_n (0.5) = \underline{\hspace{2cm}} \text{ ft/sec}$

Eq. 2 $v_{min} = v_n R_{min} = \underline{82.5} \text{ ft/sec}$

Calculate R_{max} .

$$R_{max} = 0.4457 + \left[0.5690 + \frac{0.2603 (\sqrt{Q_s}) \mu_s}{v_n^{1.5}} \right] = \underline{1.24}$$

Plant: ONIZUKA AFB

Date: 12-3-93

Source/Sample Number: OAFB-1

If R_{\max} is greater than 1.5, use Equation 3 to calculate v_{\max} . Otherwise, use Equation 4.

Eq. 3 $v_{\max} = v_n (1.5) = \underline{\hspace{2cm}}$ ft/sec

Eq. 4 $v_{\max} = v_n R_{\max} = \underline{136.4}$ ft/sec

Maximum and minimum velocity head values:

$$\Delta p_{\min} = 1.3686 \times 10^{-4} \frac{P_s M_w (v_{\min})^2}{(t_s + 460) C_p^2} = \underline{1.25} \text{ in. H}_2\text{O}$$

$$\Delta p_{\max} = 1.3686 \times 10^{-4} \frac{P_s M_w (v_{\max})^2}{(t_s + 460) C_p^2} = \underline{3.41} \text{ in. H}_2\text{O}$$

Calculate the actual D_{50} of the cyclone for the given conditions as follows:

$$D_{50} = \beta_1 \left(\frac{t_s + 460}{M_w P_s} \right)^{0.2091} \times \left(\frac{\mu_s}{Q_s} \right)^{0.7091}$$

where, $\beta_1 = 0.15625$

$$D_{50} = (0.15625) \left(\frac{910}{(2858)(30.1)} \right)^{0.2091} \times \left(\frac{279.6}{0.81} \right)^{0.7091}$$

$$D_{50} = \underline{9.97} \text{ } \mu\text{m}$$

CLIENT: ONIZUKA AFB

Project No. F028

PM 10
TEST #1

PARTICULATE CALCULATIONS

Sampling Location: TURBINE #2 EXHAUST Test Date: 12-03-93

Sample Number: DAFB-1 Sample Volume: 90.1 DSCF

Stack Flow Rate: 12,300 DSCFM

<u>Particulate Catch:</u>		(grams)	PM10	>PM10	
Filter:	Final Weight		<u>0.2084</u>		
	Initial Weight		<u>0.2083</u>		
	Net Weight		<u>0.0001</u>		
<u>ACETONE</u>					
Impinger:	Final Weight		<u>28.6871</u>	<u>29.0835</u>	
	Initial Weight		<u>28.6878</u>	<u>29.0832</u>	
	Net Weight		<u>-0.0007</u>	<u>0.0003</u>	
Extract:	Final Weight				
	Initial Weight				
	Net Weight				
Total:			<u><0.0010</u>	<u><0.0010</u>	

Particulate Concentration:

$$\frac{(\text{<0.001}) \text{ grams} \times 15.43 \text{ grains/gram}}{(\text{90.1}) \text{ DSCF}} = \text{<0.0002} \text{ grains/DSCF}$$

Particulate Emissions:

$$\frac{(\text{<0.0002}) \text{ gr/DSCF} \times (\text{12,300}) \text{ DSCFM} \times 60 \text{ min/hr}}{7000 \text{ grains/lb}} = \text{<0.02} \text{ lbs/hr}$$

Rule 404 Limitation @ NA SCFM = _____ grains/DSCF

Rule 405 Limitation @ NA lbs/hr = _____ lbs/hr

SAMPLE RETRIEVAL DATA

Plant: ONIZUKA AFB
 Date: 12-3-93
 Sampling Location: TURBINE #2 STACK
 Sampling Type (Method): PM-10
 Run Number: 0AFB-2
 Sample Box Number: 3B
 Clean-up Man: BROWN, KEARNEY
 Job Number: F028
 Comments: _____

Filter

Filter Number: _____
 Description of Filter: CLEAN _____

Moisture

	#1	#2	#3
Impingers:			
Final Volume:	<u>156.0</u> mL	<u>108</u> mL	<u>3.0</u> mL
Initial Volume:	<u>100.0</u> mL	<u>100.0</u> mL	<u>0.0</u> mL
Net Volume:	<u>56</u> mL	<u>8</u> mL	<u>3</u> mL
Total H ₂ O:	<u>56</u> mL	<u>64</u> mL	<u>67</u> mL

Silica Gel

Final Volume:	<u>682.3</u> g	_____ g	_____ g
Initial Volume:	<u>659.7</u> g	_____ g	_____ g
Net Volume:	<u>22.6</u> g	_____ g	_____ g
Total Moisture:	<u>89.6</u> g	_____ g	_____ g

Description of Impinger catch: CLEAR

Plant: ONIZUKA AFB

Date: 12-3-73

Source/Sample Number: 0AFB-2

1. $V_m(\text{std}) = (17.64)(V_m)(Y) \left[\frac{P_{\text{bar}} + (\Delta H/13.6)}{T_m} \right]$

$$V_m(\text{std}) = (17.64)(93.092)(0.99) \left[\frac{(302) + (2.3/13.6)}{(547)} \right]$$

$$V_m(\text{std}) = \underline{90.3} \text{ dscf.}$$

2. Volume water vapor collected (standard conditions).

$$V(10) = \underline{89.6} \text{ condensate from impingers and silica gel.}$$

$$V_w(\text{std}) = (0.04707) V(10) = (0.04707)(89.6)$$

$$V_w(\text{std}) = \underline{4.22} \text{ scf.}$$

3. Percent moisture, by volume.

$$Bw_s = \frac{V_w(\text{std})}{V_w(\text{std}) + V_m(\text{std})} = \frac{(4.22)}{(4.22) + (90.3)} = \underline{0.045}$$

$$Bw_s = \underline{4.5\%}.$$

4. Molecular weight, stack gas.

Dry molecular weight.

$$M_d = 0.440(\% \text{ CO}_2) + 0.320(\% \text{ O}_2) + 0.280(\% \text{ N}_2 + \% \text{ CO})$$

$$M_d = 0.440(2.5) + 0.320(17.5) + 0.280(80)$$

$$M_d = \underline{29.1} \text{ lb/lb-mole.}$$

$$M_s = M_d + Bw_s (18 - M_d) = (29.1) + (0.045)(18 - 29.1)$$

$$M_s = \underline{28.6} \text{ lb/lb-mole.}$$

Plant: ONIZUKA AFB

Date: 12-3-93

Source/Sample Number: 0AFB-2

5. Stack gas velocity average.

$$V_s(\text{avg}) = (85.49)(C_p)(\sqrt{\Delta P}) \left[\text{avg} \sqrt{\frac{(T_s)}{(P_s)(M_s)}} \right]$$

$$V_s(\text{avg}) = (85.49)(0.84)(1.58) \left[\sqrt{\frac{(917)}{(30.1)(28.6)}} \right]$$

$$V_s(\text{avg}) = \underline{117.1} \text{ ft/sec.}$$

6. Stack volumetric flow rate, actual conditions (stack temperature and pressure).

$$Q_s = (60)(V_s)(A) = (60)(117.1)(3.14)$$

$$Q_s = \underline{22062} \text{ acfm.}$$

7. Stack volumetric flow rate, standard conditions (68 degrees F, 29.92 Hg).

$$Q(\text{std}) = (17.64)(Q_s)(1 - B_{ws}) \left[\frac{(P_s)}{(T_s)} \right]$$

$$Q(\text{std}) = (17.64)(22062)(1 - 0.045) \left[\frac{(30.1)}{(917)} \right]$$

$$Q(\text{std}) = \underline{12200} \text{ dscfm.}$$

8. Isokinetic variation.

$$\%I = (K) \left[\frac{(T_s)(V_m(\text{std}))}{(P_s)(V_s)(A_n)(\theta)(1 - B_{ws})} \right]$$

$$\%I = (0.0945) \left[\frac{(\quad)(\quad)(\quad)}{(\quad)(\quad)(\quad)(\quad)(1 - \quad)} \right]$$

$$\%I = \underline{N/A} \%$$

Plant: ONIZUKA AFB

Date: 12-3-93

Source/Sample Number: 0AFB-2

9. Viscosity of stack gas:

$$\begin{aligned}\mu_s &= 152.418 + 0.2552 t_s + 3.2355 \times 10^{-5} (t_s)^2 + \\ &\quad 0.53147 (\%O_2) - 74.143 Bw_s \\ \mu_s &= 152.418 + 0.2552 (457) + 3.2355 \times 10^{-5} (457)^2 + \\ &\quad 0.53147 (17.5) - 74.143 (0.045) \\ \mu_s &= \underline{281.8} \text{ micropoise.}\end{aligned}$$

10. Cyclone flow rate:

$$\begin{aligned}Q_s &= 0.002837 \mu_s \left(\frac{t_s + 460}{M_w P_s} \right)^{0.2949} \\ Q_s &= 0.002837 (281.8) \left(\frac{(\cancel{457}) + 460}{(28.6)(30.1)} \right)^{0.2949} \\ Q_s &= \underline{0.81} \text{ ft}^3/\text{min}\end{aligned}$$

11. Orifice pressure head for cyclone flow rate:

$$\begin{aligned}\Delta H &= \left(\frac{Q_s (1 - Bw_s) P_s}{t_s + 460} \right)^2 \left(\frac{(t_s + 460) M_s (1.083) \Delta H_0}{P_{bar}} \right) \\ \Delta H &= \left(\frac{(0.81)(1 - 0.045)(30.1)}{(457) + 460} \right)^2 \left(\frac{(87 + 460)(29.1)(1.083)(1.916)}{(30.2)} \right) \\ \Delta H &= \underline{0.71} \text{ in. H}_2\text{O}\end{aligned}$$

Plant: ONIZUKA AFB

Date: 12-3-93

Source/Sample Number: 0AFB-2

Stack viscosity, μ_s , micropoise = 281.8
Absolute stack pressure, P_s , in. Hg = 30.1
Average stack temperature, t_s , °F = 457
Meter temperature, t_m , °F = 87
Method 201A pitot coefficient, C_p = 0.84
Cyclone flow rate, Q_s , ft³/min = 0.81
Method 2 pitot coefficient, C_p = 0.84
Molecular weight of stack gas, wet basis, M_w = 28.6
Nozzle diameter, D_n , in. = 0.150

Nozzle velocity

$$v_n = \frac{3.056 Q_s}{D_n^2} = \underline{110.0} \text{ ft/sec}$$

Maximum and minimum velocities:

Calculate R_{min} .

$$R_{min} = 0.2457 + \left[0.3072 - \frac{0.2603 (\sqrt{Q_s}) \mu_s}{v_n^{1.5}} \right] = \underline{0.75}$$

If R_{min} is less than 0.5, or if an imaginary number occurs when calculating R_{min} , use Equation 1 to calculate v_{min} . Otherwise, use Equation 2.

Eq. 1 $v_{min} = v_n (0.5) = \underline{\hspace{2cm}} \text{ ft/sec}$

Eq. 2 $v_{min} = v_n R_{min} = \underline{82.5} \text{ ft/sec}$

Calculate R_{max} .

$$R_{max} = 0.4457 + \left[0.5690 + \frac{0.2603 (\sqrt{Q_s}) \mu_s}{v_n^{1.5}} \right] = \underline{1.24}$$

Plant: ONIZUKA AFB

Date: 12-3-93

Source/Sample Number: DAFB-2

If R_{\max} is greater than 1.5, use Equation 3 to calculate v_{\max} . Otherwise, use Equation 4.

Eq. 3 $v_{\max} = v_n (1.5) = \underline{\hspace{2cm}}$ ft/sec

Eq. 4 $v_{\max} = v_n R_{\max} = \underline{136.4}$ ft/sec

Maximum and minimum velocity head values:

$$\Delta p_{\min} = 1.3686 \times 10^{-4} \frac{P_s M_w (v_{\min})^2}{(t_s + 460) C_p^2} = \underline{1.24} \text{ in. H}_2\text{O}$$

$$\Delta p_{\max} = 1.3686 \times 10^{-4} \frac{P_s M_w (v_{\max})^2}{(t_s + 460) C_p^2} = \underline{3.39} \text{ in. H}_2\text{O}$$

Calculate the actual D_{50} of the cyclone for the given conditions as follows:

$$D_{50} = \beta_1 \left(\frac{t_s + 460}{M_w P_s} \right)^{0.2091} \times \left(\frac{\mu_s}{Q_s} \right)^{0.7091}$$

where, $\beta_1 = 0.15625$

$$D_{50} = (0.15625) \left(\frac{917}{(28.6)(35.1)} \right)^{0.2091} \times \left(\frac{281.8}{0.81} \right)^{0.7091}$$

$$D_{50} = \underline{10.04} \text{ } \mu\text{m}$$



CLIENT: ONIZUKA AFB

Project No. F028

PARTICULATE CALCULATIONS PM10 TEST #2

Sampling Location: TURBINE #2 EXHAUST Test Date: 12-03-94

Sample Number: 0AFB-2 Sample Volume: 90.3 DSCF

Stack Flow Rate: 12,200 DSCFM

<u>Particulate Catch:</u>		(grams) <u>PM10</u>	<u>>PM10</u>	
Filter:	Final Weight	<u>0.2066</u>		
	Initial Weight	<u>0.2072</u>		
	Net Weight	<u>-0.0006</u>		
<u>ACETONE</u> <u>Impinger:</u>	Final Weight	<u>28.6117</u>	<u>28.3456</u>	
	Initial Weight	<u>28.6117</u>	<u>28.3443</u>	
	Net Weight	<u>0.0000</u>	<u>0.0013</u>	
Extract:	Final Weight			
	Initial Weight			
	Net Weight			
Total:		<u><0.0010</u>	<u>0.0013</u>	

Particulate Concentration:

$$\frac{(<0.0010) \text{ grams} \times 15.43 \text{ grains/gram}}{(90.3) \text{ DSCF}} = \underline{<0.0002} \text{ grains/DSCF}$$

Particulate Emissions:

$$\frac{(<0.0002) \text{ gr/DSCF} \times (12,200) \text{ DSCFM} \times 60 \text{ min/hr}}{7000 \text{ grains/lb}} = \underline{<0.02} \text{ lbs/hr}$$

Rule 404 Limitation @ NA SCFM = _____ grains/DSCF

Rule 405 Limitation @ NA lbs/hr = _____ lbs/hr

Plant	ONIZUKA AFB	Probe Length and Type	55 - 5 FT - 6 INGS LINED
Date	12-3-93	Pilot Tube I.D. No.	5-17A
Sampling Location	TURBINE #2 STACK	Nozzle I.D. No. & DIAMETER	0.150
Sample Type	PM-10	Assumed Moisture, %	5.0
Run Number	QAEB-3	Meter Box Number	3A
Operator	BROWN	Meter Aliq	1.916
Ambient Temperature	75	C Factor	-
Barometric Pressure	30.2	Meter Gamma	0.99
Static Pressure (P _{st})	-1.25	Heater Box Setting	-
Filter Number(s)	-	Reference ΔP	-
Pretest Leak Rate =	0.007 cfm @ 5 in. Hg	Post Test Leak Rate =	0.010 cfm @ 5 in. Hg
Pretest Pitot Leak Check	OK	Post Test Pitot Leak Check	OK
Pretest Orsat Leak Check	-	Post Test Orsat Leak Check	-
Read and Record all Data Every	15 Minutes	Imaging Box No. 3B	Blank Box No. -

(SEE TEST #1)

Schematic of
Traverse Point Layout

Traverse Point Number	Sampling Time, / (min) / clock)	/Clock Time, / (24-hour clock)	Gas Meter Reading (V _m) ft.	Velocity Head (ΔP_B) In. H ₂ O	Orifice Pres. Differential (ΔH) In. H ₂ O <u>Desired</u> <u>Actual</u>	Stack Temp. (T _s) °F	Dry Gas Meter Temp. Inlet (T _m) _{In} °F Outlet (T _m) _{out} °F	Pump Vacuum in. Hg	Sample Box Temp. Filter Temp. °F	Im- pinging Temp. °F	M.D.
R 4	0	13:54	607.078	2.8	2.2	460	80	4.2	-	43	15.3
3	15.3	14:09	619.1	2.5	2.2	463	89	4.3	-	52	14.4
2	29.7	14:23	630.8	2.4	2.2	465	92	4.4	-	54	14.1
(1) 2	43.8	14:37	642.1	2.4	2.2	467	91	4.4	-	55	14.1
FINI	57.9	14:51	653.4	-	-	-	-	-	-	-	
L 4	57.9	14:55	653.4	2.6	2.2	448	83	4.5	-	55	14.7
3	72.6	15:10	665.2	2.6	2.2	449	82	4.5	-	57	14.7
2:	87.3	15:25	677.0	2.1	2.2	464	81	4.6	-	60	13.2
(1) 2	100.5	15:38	687.6	2.1	2.2	463	83	4.8	-	63	13.2
FINI	113.7	15:51	698.155	-	-	-	-	-	-	-	
			V _m =91.077	X 1.56 ✓ √ΔP = 2.44	ΔH= 2.2	T _s =460	T _m = 82			≤ 68	
GAS	METER / X100		948.907	302.905							
	13:09 /		999.030	303.144							
	16:53 /		323	239	2.74						
					HRS						

SAMPLE RETRIEVAL DATA

Plant: ONIZUKA AFB
 Date: 12-3-93
 Sampling Location: TURBINE #2 STACK
 Sampling Type (Method): PM-10
 Run Number: 0AFB-3
 Sample Box Number: 3B
 Clean-up Man: BROWN, KEARNEY
 Job Number: F028
 Comments: _____

Filter

Filter Number: _____
 Description of Filter: _____

Moisture

Impingers:				
Final Volume:	<u>154.0</u>	<u>mL</u>	<u>106.0</u>	<u>mL</u>
Initial Volume:	<u>100.0</u>	<u>mL</u>	<u>100.0</u>	<u>mL</u>
Net Volume:	<u>54</u>	<u>mL</u>	<u>6.0</u>	<u>mL</u>
Total H ₂ O:	<u>54</u>	<u>mL</u>	<u>60</u>	<u>mL</u>

Silica Gel

Final Volume:	<u>715.2</u>	<u>g</u>	<u> </u>	<u>g</u>
Initial Volume:	<u>690.1</u>	<u>g</u>	<u> </u>	<u>g</u>
Net Volume:	<u>25.1</u>	<u>g</u>	<u> </u>	<u>g</u>
Total Moisture:	<u>88.1</u>	<u>g</u>	<u> </u>	<u>g</u>

Description of Impinger catch: _____

Plant: ONIZUKA AFB

Date: 12-3-93

Source/Sample Number: 0AFB-3

$$1. Vm(std) = (17.64)(Vm)(Y) \left[\frac{P_{bar} + (\Delta H/13.6)}{T_m} \right]$$

$$Vm(std) = (17.64)(91.077)(0.99) \left[\frac{(30.2) + (2.2/13.6)}{(542)} \right]$$

$$Vm(std) = \underline{89.1} \text{ dscf.}$$

2. Volume water vapor collected (standard conditions).

$$V(1o) = \underline{88.1} \text{ condensate from impingers and silica gel.}$$

$$Vw(std) = (0.04707) V(1o) = (0.04707)(88.1)$$

$$Vw(std) = \underline{4.15} \text{ scf.}$$

3. Percent moisture, by volume.

$$Bw_s = \frac{Vw(std)}{Vw(std) + Vm(std)} = \frac{(4.15)}{(4.15) + (89.1)} = \underline{0.045}$$

$$Bw_s = \underline{4.5\%}$$

4. Molecular weight, stack gas.

Dry molecular weight.

$$Md = 0.440(\% CO_2) + 0.320(\% O_2) + 0.280(\% N_2 + \% CO)$$

$$Md = 0.440(2.5) + 0.320(17.5) + 0.280(80)$$

$$Md = \underline{29.1} \text{ lb/lb-mole.}$$

$$Ms = Md + Bw_s (18 - Md) = (29.1) + (0.045)(18 - 29.1)$$

$$Ms = \underline{28.6} \text{ lb/lb-mole.}$$

Plant: ONIZUKA AFB

Date: 12-3-93

Source/Sample Number: 0AFB-3

5. Stack gas velocity average.

$$V_s(\text{avg}) = (85.49)(C_p)(\sqrt{\Delta P}) \left[\text{avg} \sqrt{\frac{(T_s)}{(P_s)(M_s)}} \right]$$
$$V_s(\text{avg}) = (85.49)(0.84)(1.56) \left[\sqrt{\frac{(920)}{(30.1)(28.6)}} \right]$$

$$V_s(\text{avg}) = \underline{115.8} \text{ ft/sec.}$$

6. Stack volumetric flow rate, actual conditions (stack temperature and pressure).

$$Q_s = (60)(V_s)(A) = (60)(115.8)(3.14)$$

$$Q_s = \underline{21817} \text{ acfm.}$$

7. Stack volumetric flow rate, standard conditions (68 degrees F, 29.92 Hg).

$$Q(\text{std}) = (17.64)(Q_s)(1 - B_{ws}) \left[\frac{(P_s)}{(T_s)} \right]$$

$$Q(\text{std}) = (17.64)(21817)(1 - 0.045) \left[\frac{(30.1)}{(920)} \right]$$

$$Q(\text{std}) = \underline{1202.5} \text{ dscfm.}$$

8. Isokinetic variation.

$$\%I = (K) \left[\frac{(T_s)(V_m(\text{std}))}{(P_s)(V_s)(A_n)(\theta)(1 - B_{ws})} \right]$$

$$\%I = (0.0945) \left[\frac{(\quad)(\quad)(\quad)}{(\quad)(\quad)(\quad)(\quad)(1 - \quad)} \right]$$

$$\%I = \underline{N/A} \%$$

Plant: ONIZUKA AFB

Date: 12-3-93

Source/Sample Number: 0AFB-3

9. Viscosity of stack gas:

$$\mu_s = 152.418 + 0.2552 t_s + 3.2355 \times 10^{-5} (t_s)^2 + 0.53147 (\%O_2) - 74.143 Bw_s$$

$$\mu_s = 152.418 + 0.2552 (460) + 3.2355 \times 10^{-5} (460)^2 + 0.53147 (17.5) - 74.143 (0.045)$$

$$\mu_s = \underline{282.6} \text{ micropoise.}$$

10. Cyclone flow rate:

$$Q_s = 0.002837 \mu_s \left(\frac{t_s + 460}{M_w P_s} \right)^{0.2949}$$

$$Q_s = 0.002837 (282.6) \left(\frac{(460) + 460}{(28.6) (30.1)} \right)^{0.2949}$$

$$Q_s = \underline{0.82} \text{ ft}^3/\text{min}$$

11. Orifice pressure head for cyclone flow rate:

$$\Delta H = \left(\frac{Q_s (1 - Bw_s) P_s}{t_s + 460} \right)^2 \left(\frac{(t_s + 460) M_s (1.083) \Delta H@}{P_{bar}} \right)$$

$$\Delta H = \left(\frac{(0.82) (1 - 0.045) (30.1)}{(460) + 460} \right)^2 \left(\frac{(82 + 460) (29.1) (1.083) (1.916)}{(30.2)} \right)$$

$$\Delta H = \underline{0.71} \text{ in. H}_2\text{O}$$

Plant: ONIZUKA AFB

Date: 12-3-93

Source/Sample Number: DAFB-3

Stack viscosity, μ_s , micropoise = 282.6
Absolute stack pressure, P_s , in. Hg = 30.1
Average stack temperature, t_s , °F = 460
Meter temperature, t_m , °F = 82
Method 201A pitot coefficient, C_p = 0.84
Cyclone flow rate, Q_p , ft³/min, Q_p = 0.82
Method 2 pitot coefficient, C_p = 0.84
Molecular weight of stack gas, wet basis, M_w = 28.6
Nozzle diameter, D_n , in. = 0.150

Nozzle velocity

$$v_n = \frac{3.056 Q_s}{D_n^2} = \underline{111.4} \text{ ft/sec}$$

Maximum and minimum velocities:

Calculate R_{min} .

$$R_{min} = 0.2457 + \left[0.3072 - \frac{0.2603 (\sqrt{Q_s}) \mu_s}{v_n^{1.5}} \right] = \underline{0.75}$$

If R_{min} is less than 0.5, or if an imaginary number occurs when calculating R_{min} , use Equation 1 to calculate v_{min} . Otherwise, use Equation 2.

Eq. 1 $v_{min} = v_n (0.5) = \underline{\hspace{2cm}} \text{ ft/sec}$

Eq. 2 $v_{min} = v_n R_{min} = \underline{83.6} \text{ ft/sec}$

Calculate R_{max} .

$$R_{max} = 0.4457 + \left[0.5690 + \frac{0.2603 (\sqrt{Q_s}) \mu_s}{v_n^{1.5}} \right] = \underline{1.24}$$

Plant: ONIZUKA AFB

Date: 12-3-93

Source/Sample Number: DAFB-3

If R_{\max} is greater than 1.5, use Equation 3 to calculate v_{\max} . Otherwise, use Equation 4.

Eq. 3 $v_{\max} = v_n (1.5) = \underline{\hspace{2cm}}$ ft/sec

Eq. 4 $v_{\max} = v_n R_{\max} = \underline{138.1}$ ft/sec

Maximum and minimum velocity head values:

$$\Delta p_{\min} = 1.3686 \times 10^{-4} \frac{P_s M_w (v_{\min})^2}{(t_s + 460) C_p^2} = \underline{1.27} \text{ in. H}_2\text{O}$$

$$\Delta p_{\max} = 1.3686 \times 10^{-4} \frac{P_s M_w (v_{\max})^2}{(t_s + 460) C_p^2} = \underline{3.46} \text{ in. H}_2\text{O}$$

Calculate the actual D_{50} of the cyclone for the given conditions as follows:

$$D_{50} = \beta_1 \left(\frac{t_s + 460}{M_w P_s} \right)^{0.2091} \times \left(\frac{\mu_s}{Q_s} \right)^{0.7091}$$

where, $\beta_1 = 0.15625$

$$D_{50} = (0.15625) \left(\frac{920}{(28.6)(30.1)} \right)^{0.2091} \times \left(\frac{282.6}{0.32} \right)^{0.7091}$$

$$D_{50} = \underline{9.98} \text{ } \mu\text{m}$$

CLIENT: DNIZUKA AFB

Project No. F028

PARTICULATE CALCULATIONS

PM10 TEST #3

Sampling Location: TURBINE #2 EXHAUST Test Date: 12-03-94

Sample Number: 0AFB-3 Sample Volume: 89.1 DSCF

Stack Flow Rate: 12,030 DSCFM

<u>Particulate Catch:</u>		(grams) PM10	> PM10	
Filter:	Final Weight	<u>0.2056</u>		
	Initial Weight	<u>0.2065</u>		
	Net Weight	<u>-0.0009</u>		
Impinger:	Final Weight	<u>28.6882</u>	<u>28.1727</u>	
	Initial Weight	<u>28.6882</u>	<u>28.1721</u>	
	Net Weight	<u>0.0000</u>	<u>0.0006</u>	
Extract:	Final Weight			
	Initial Weight			
	Net Weight			
Total:		<u><0.0010</u>	<u>0.0006</u>	

Particulate Concentration:

$$\frac{(\underline{<0.0010}) \text{ grams} \times 15.43 \text{ grains/gram}}{(\underline{89.1}) \text{ DSCF}} = \underline{<0.0002} \text{ grains/DSCF}$$

Particulate Emissions:

$$\frac{(\underline{<0.0002}) \text{ gr/DSCF} \times (\underline{12,030}) \text{ DSCFM} \times 60 \text{ min/hr}}{7000 \text{ grains/lb}} = \underline{<0.02} \text{ lbs/hr}$$

Rule 404 Limitation @ NA SCFM = _____ grains/DSCF

Rule 405 Limitation @ NA lbs/hr = _____ lbs/hr



PACIFIC ENVIRONMENTAL SERVICES, INC.

Project No. F028		Page 1 of 1	
Client ONIZUKA AFB			
Location TURBINE #2			
Prepared By ★	Date 12/16/93	Checked By SJB	Sheet Title PM-10

BEAKER	POST WEIGHT g	PRE WEIGHT g	NET g
1A	29.0835	29.0832	0.0003
2A	28.3456	28.3443	0.0013
3A	28.1727	28.1721	0.0006
1B	28.6871	28.6878	-0.0007
2B	28.6117	28.6117	0.0000
3B	28.6882	28.6882	0.0000

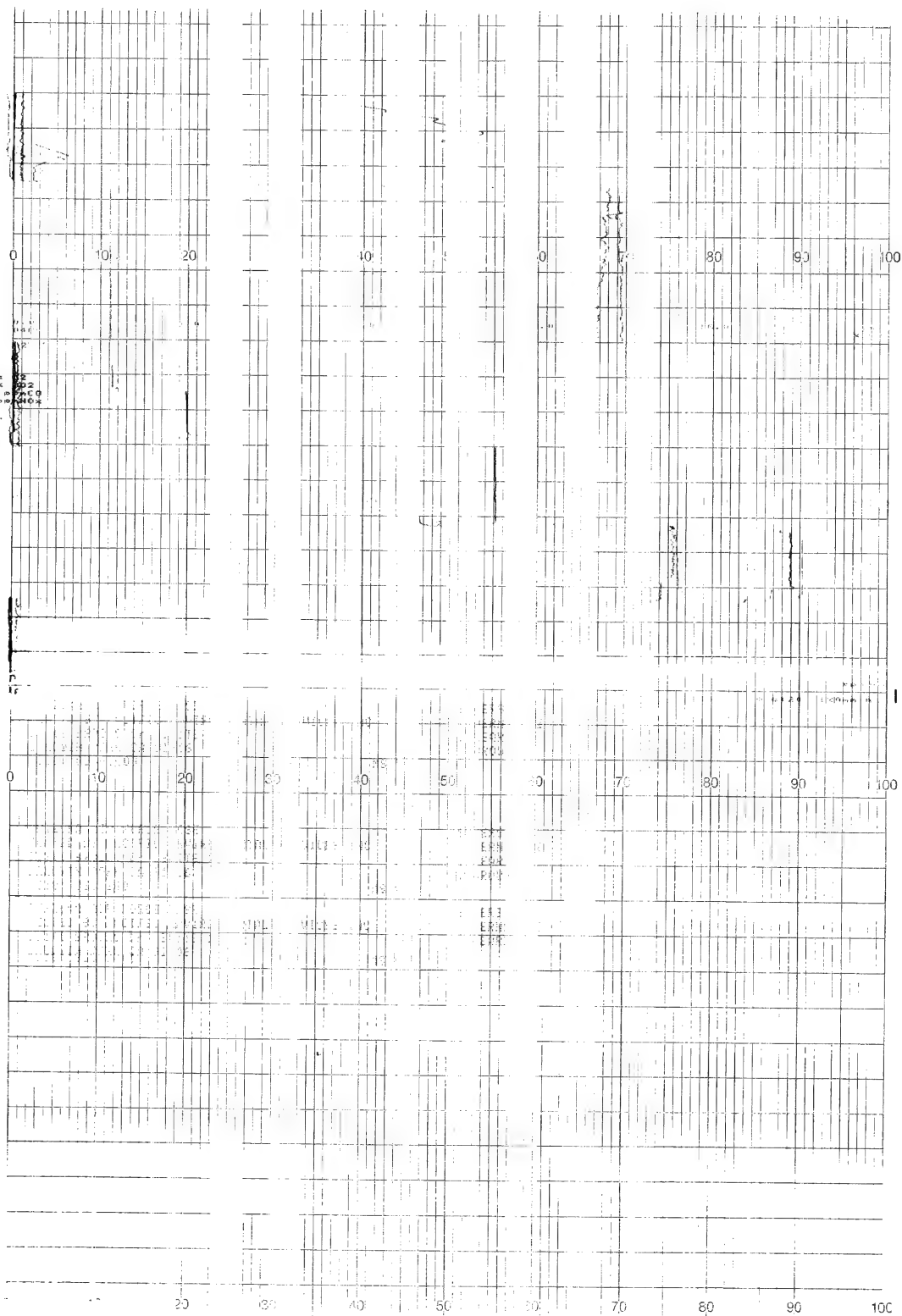
NOTE: NO SIGNIFICANT CATCHES

I.E. < 1 mg PM10
< 1 mg > PM10

FILTERS:

1	0.2084	0.2083	0.0001
2	0.2066	0.2072	-0.0006
3	0.2056	0.2065	-0.0009

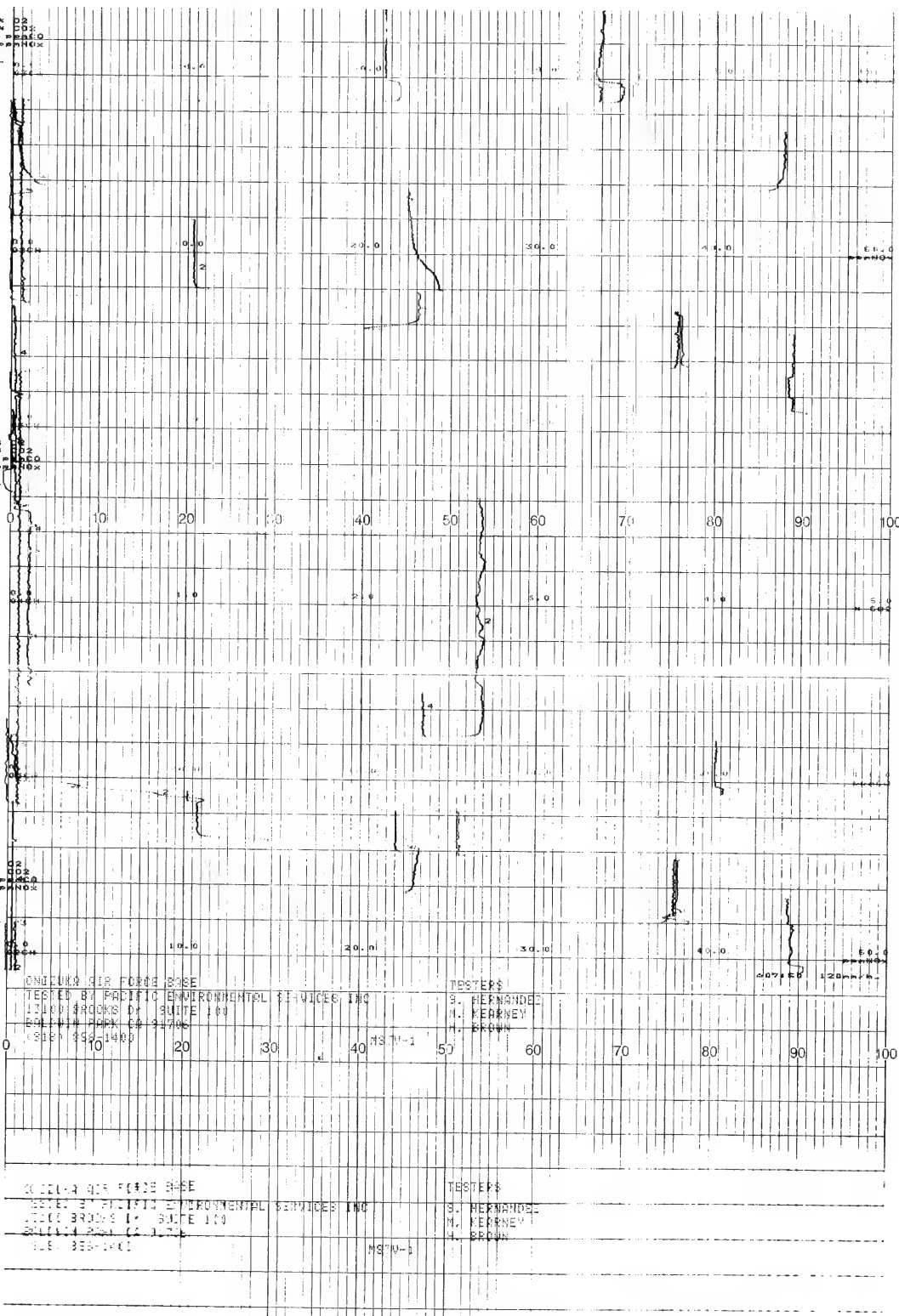
05 0.0%
 06 3.0%
 07 0.5%
 08 0.0%
 120mm
 Dec. 02 17:00



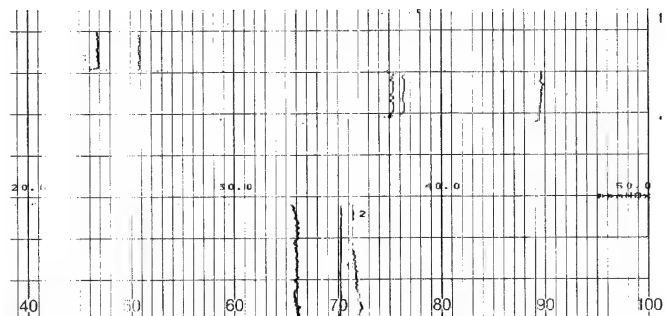
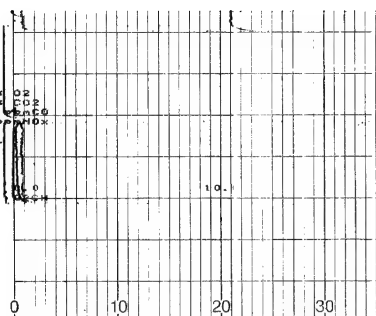
05 17.7% D2
04 2.1% D2
03 64.2% D2
02 33.2% D2
Dec. 03 10:00

05 17.6% D2
04 0.0% D2
03 0.9% D2
02 -0.3% D2
Dec. 03 09:00

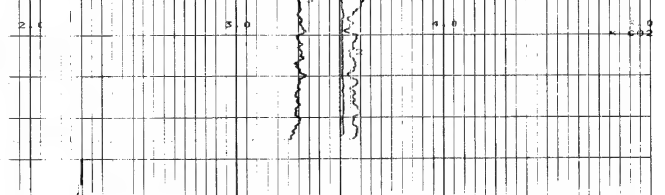
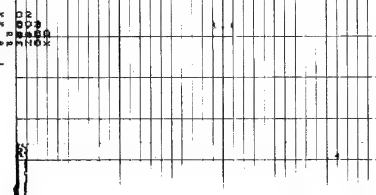
05 19.1% D2
04 0.0% D2
03 75.6% D2
02 44.2% D2
Dec. 03 08:00



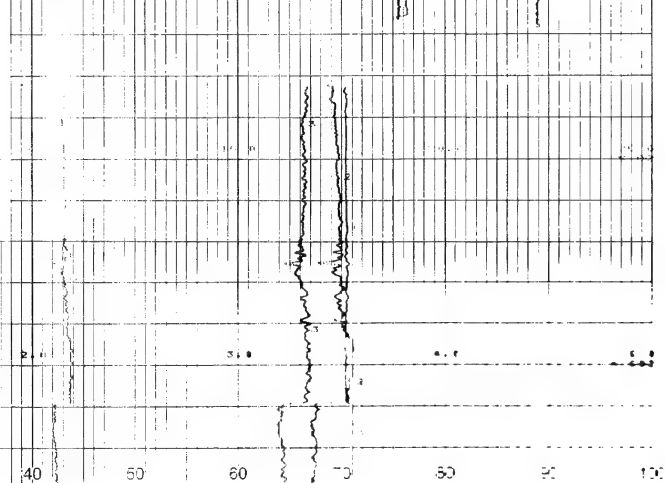
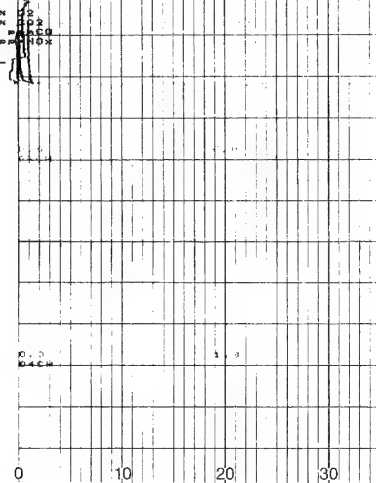
05 0.0M 02
 04 0.0M 02
 03 0.7 02
 02 0.1 02
 120mm/h
 Dec. 03 13:00-



05 17.5M 02
 04 2.1M 02
 03 65.5 02
 02 35.7 02
 120mm/h
 Dec. 03 12:00-



05 0.0M 02
 04 0.0M 02
 03 0.9 02
 02 0.1 02
 120mm/h
 Dec. 03 11:00-



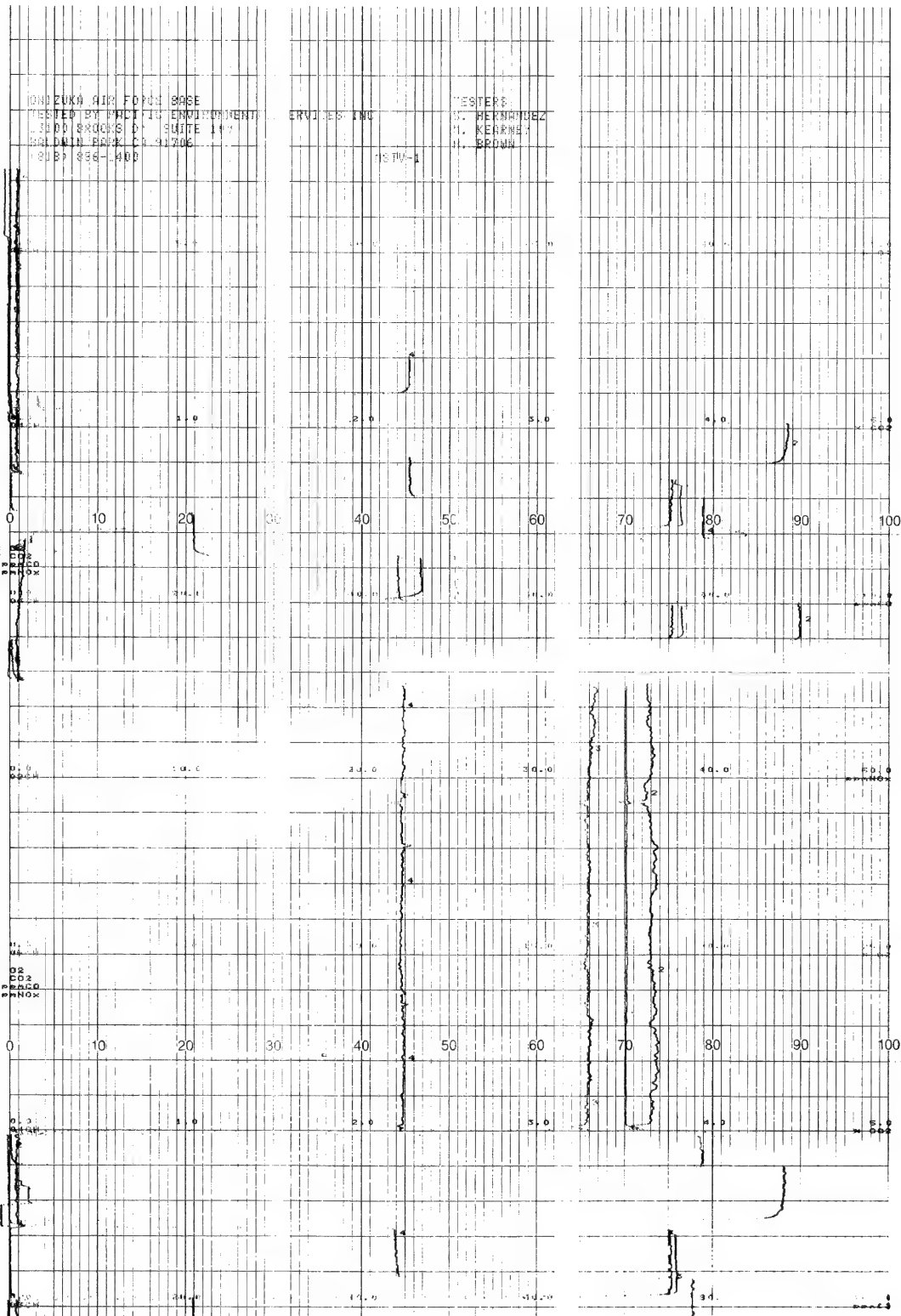
ONIZUKA AIR FORCE BASE
TESTED BY PACIFIC ENVIRONMENT
3000 BROOKS DRIVE SUITE 100
BALDWIN PARK CA 91706
SUB 888-1400

ERUIES INC
WESTERS
M. PEREZ
M. KENNEDY
M. BROWN

15TH-1

05 11.0M
04 0.0M
03 60.0
02 23.3
Dec. 03 15:00

05 17.5M
04 2.2M
03 65.4
02 36.7
Dec. 03 15:00





PACIFIC ENVIRONMENTAL SERVICES, INC.

Project No.

F028.000

Page

1 of 8

Client

ONIZUKA, DEB

Location

SUNNYVALE, CA

Prepared By

SMH

Date

12-3

Checked By

N/A

Date

-

Sheet Title VAL @ START 19.8" Hg - 19.8" @ END

(24" Ø STACK)

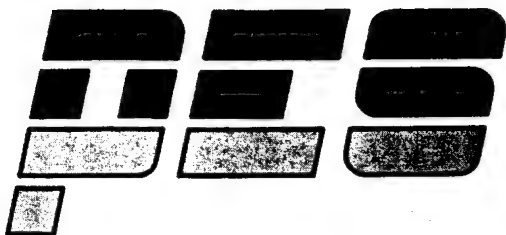
Run 1

(CARB 20)

TIME	NO _x	CO	CO ₂	O ₂	NOTES
--	0.0	0.9	0.0	0.0	ZERO @ 0.0 ← 209:20
--	44.2	75.6	19.0	19.0	H-SPAN 44.4
--	23.1	51.0	2.3	11.0	M-SPAN 22.3
--	10.7	--	--	--	L-SPAN 10.4
08:23	26.8	--	--	--	CONVERTER CHECK (NO _x)
08:53	26.5	--	--	--	END CONVERTER CHECK
08:26	--	--	--	17.6	O ₂ TRAVERSE R 8 (4) SE
--	--	--	--	17.6	R 7 (3)
--	--	--	--	17.6	R 6 (2)
--	--	--	--	17.6	R 5 (1)
--	--	--	--	17.6	R 4 (4) NE
--	--	--	--	17.6	R 3 (3)
--	--	--	--	17.7	R 2 (2)
--	--	--	--	17.6	R 1 (1)
--	43.8	75.5	2.2	19.0	BIAS (HIGH)

START Run 1

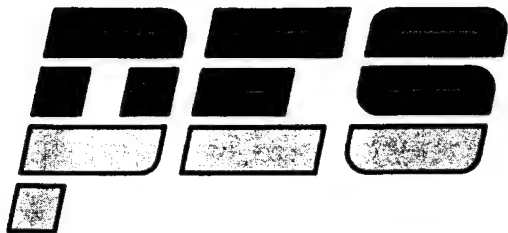
09:56	34.7	66.6	2.1	17.5	@ R 4 F/S CO ₂ = 15% 5%
09:57	34.7	66.6	2.1	17.5	@ 0.250 VOL
09:58	34.0	65.2	2.1	17.6	
09:59	33.1	64.2	2.1	17.7	
10:00	33.2	64.2	2.1	17.7	
10:01	33.2	64.1	2.1	17.7	
10:02	33.3	64.2	2.1	17.7	
10:03	33.4	64.4	2.1	17.7	
10:04	33.5	64.4	2.1	17.7	
10:05	33.4	64.1	2.1	17.7	



PACIFIC ENVIRONMENTAL SERVICES, INC.

Project No.	F028.000	Page	2	of	8
Client	ONIZUKA AFB				
Location	SUNNYVALE, CA				
Prepared By	Date	Checked By	Date	Sheet Title	
SWH	12-3	N/A	-	Run 1	

TIME	NO _x	CO	CO ₂	O ₂	NOTES:
10:06	33.5	64.4	17.7	17.7	
10:07	33.5	64.3	2.1	17.7	
10:08	33.5	64.3	2.1	17.7	
10:09	33.5	64.3	2.1	17.7	
10:10	33.6	64.1	2.1	17.7	MOVED to R-3 SWH
10:11	33.6	64.2	2.1	17.7	
10:12	33.6	64.2	2.1	17.7	
10:13	33.7	64.3	2.1	17.7	
10:14	33.7	64.1	2.1	17.7	
10:15	33.6	63.8	2.0	17.7	(20 min)
10:16	33.5	63.9	2.1	17.7	
10:17	33.7	64.1	2.1	17.7	ACTUAL POINT CHANGE
10:18	34.6	65.2	2.1	17.6	CHANGES OBSERVED ON STRIP CHART.
10:19	35.2	66.4	2.1	17.6	
10:20	35.3	66.7	2.1	17.6	
10:21	35.5	66.9	2.1	17.5	
10:22	35.4	66.6	2.1	17.5	
10:23	35.5	66.5	2.1	17.5	
10:24	35.5	66.5	2.1	17.5	
10:25	35.5	66.5	2.1	17.5	(30 min)
10:26	35.3	66.5	2.1	17.5	
10:27	35.2	66.5	2.1	17.6	
10:28	35.1	66.6	2.1	17.5	
10:29	35.0	66.6	2.1	17.5	
10:30	34.7	66.3	2.1	17.6	
10:31	34.7	66.0	2.1	17.6	
10:32	35.0	66.0	2.1	17.6	
10:33	35.0	66.0	2.1	17.6	
10:34	34.6	65.6	2.1	17.6	
10:35	34.9	65.8	2.1	17.6	(40 min)



PACIFIC ENVIRONMENTAL SERVICES, INC.

Project No.

Page 3 of 8

Client

ONIZUKA AFB

Location

SUNNYVALE, CA

Prepared By

Sam

Date

12-3

Checked By

N/A

Date

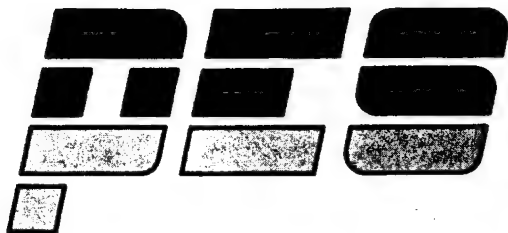
-

Sheet Title

RUN1

TIME	NO _x	CO	CO ₂	O ₂	NOTES:
10:36	34.7	65.8	2.1	17.6	
10:37	34.9	65.9	2.1	17.6	
10:38	34.8	65.9	2.1	17.6	← now to R 3
10:39	34.8	65.8	2.1	17.6	
10:40	34.8	66.0	2.1	17.6	
10:41	34.9	66.2	2.1	17.6	
10:42	34.8	66.2	2.1	17.6	
10:43	34.8	66.4	2.1	17.6	
10:44	34.9	66.3	2.1	17.5	
10:45	34.8	66.3	2.1	17.6	(50 MIN)
10:46	34.8	66.4	2.1	17.5	
10:47	34.7	66.2	2.1	17.5 17.7	
10:48	34.7	66.5	2.1	17.5	
10:49	34.8	66.2	2.1	17.6	
10:50	34.7	66.2	2.1	17.6	
10:51	34.7	66.0	2.1	17.6	
10:52	34.7	66.1	2.1	17.6	
10:53	34.6	66.1	2.1	17.6	
10:54	34.6	66.4	2.1	17.5	
10:55	34.4	66.4	2.1	17.6	(60 MIN) { \bar{x} CO = \bar{x} CO ₂ = \bar{x} O ₂ = \bar{x} NO _x =

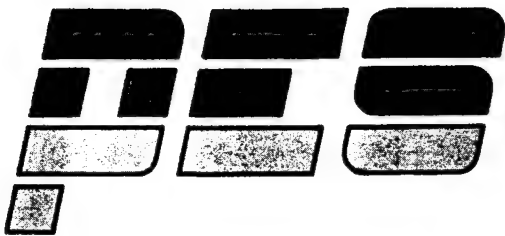
- -	0.2	1.0	0.0	0.0	ZERO
- -	44.4	75.4	4.0	19.0	H-SPAN
- -	23.1	50.8	2.2	11.0	H-SPAN
- -	10.2	- -	- -	- -	L-SPAN
- -	43.7	75.5	2.2	19.0	BIDS



PACIFIC ENVIRONMENTAL SERVICES, INC.

Project No. F028.000		Page 4 of 8	
Client ONIZUKA AFB			
Location SUNNIVALE, CA			
Prepared By SWH	Date 12-3	Checked By N/A	Sheet Title RUN 2

TIME	NO _x	CO	CO ₂	O ₂	NOTES
11:52	35.6	65.9	2.2	17.5	START TEST PL4 SE PORT
11:53	35.6	66.0	2.2	17.5	
11:54	35.6	65.8	2.1	17.5	
11:55	35.6	65.7	2.1	17.5	
11:56	35.6	65.8	2.1	17.5	
11:57	35.8	65.9	2.1	17.5	
11:58	35.8	65.8	2.1	17.5	
11:59	35.7	65.5	2.1	17.5	
12:00	35.6	65.5	2.1	17.5	
12:01	35.6	65.7	2.1	17.5	(10 MIN)
12:02	35.6	66.0	2.1	17.5	
12:03	35.6	66.0	2.2	17.5	
12:04	35.5	66.0	2.1	17.5	
12:05	35.6	66.0	2.1	17.5	
12:06	35.7	66.0	2.1	17.5	
12:07	36.0	65.9	2.1	17.5	
12:08	36.1	66.0	2.2	17.5	
12:09	36.0	66.0	2.1	17.5	
12:10	36.0	66.3	2.1	17.5	
12:11	36.1	66.0	2.1	17.5	(20 MIN) [MOVE to R 3] *
12:12	35.5	66.5	2.1	17.5	
12:13	35.3	66.7	2.1	17.5	
12:14	35.5	66.5	2.1	17.5	
12:15	35.5	66.5	2.1	17.5	
12:16	35.3	66.5	2.1	17.5	
12:17	35.5	66.4 35.5	2.1	17.5	
12:18	35.9	66.4	2.1	17.5	
12:19	35.7	66.7	2.1	17.5	
12:20	36.1	66.4	2.1	17.5	
12:21	36.2	66.1	2.1	17.5	(30 MIN)



PACIFIC ENVIRONMENTAL SERVICES, INC.

Project No.

F028.000

Page

5 of 8

Client

ONIZUKA, AFB

Location

SUNNYVALE, CA

Prepared By

SPM

Date

12.3

Checked By

N/A

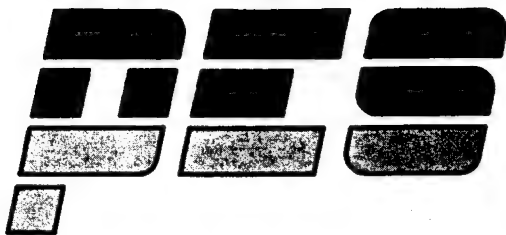
Date

-

Sheet Title

RUN 2

TIME	NO ₁	CO	CO ₂	O ₂	NOTES
12:22	36.3	66.2	2.1	17.5	
12:23	36.4	66.2	2.1	17.5	
12:24	36.4	66.1	2.1	17.5	
12:25	36.2	66.1	2.1	17.5	
12:26	36.2	66.4	2.1	17.5	
12:27	36.3	66.3	2.1	17.5	
12:28	36.4	66.2	2.1	17.4	
12:29	36.2	66.1	2.1	17.5	
12:30	36.2	66.2	2.1	17.5	
12:31	36.1	66.2	2.1	17.5	(40 MIN) [SWITCHED to R2]
12:32	36.1	66.2	2.1	17.5	
12:33	36.0	66.1	2.1	17.5	
12:34	36.0	66.0	2.1	17.5	
12:35	36.1	65.9	2.1	17.5	
12:36	36.1	66.0	2.1	17.5	
12:37	36.1	65.9	2.1	17.5	
12:38	36.1	65.8	2.1	17.5	
12:39	36.0	65.8	2.1	17.5	
12:40	36.0	65.9	2.1	17.5	
12:41	35.9	65.8	2.1	17.5	(50 MIN)
12:42	35.8	65.7	2.1	17.5	
12:43	35.8	65.9	2.1	17.5	
12:44	35.8	65.8	2.1	17.5	
12:45	35.7	65.8	2.1	17.5	
12:46	35.7	65.8	2.1	17.5	
12:47	35.6	65.8	2.1	17.5	
12:48	35.6	65.8	2.1	17.5	
12:49	35.6	65.9	2.1	17.5	
12:50	35.5	65.8	2.1	17.5	
12:51	35.6	65.8	2.1	17.5	(60 MIN)



PACIFIC ENVIRONMENTAL SERVICES, INC.

Project No.

F028.000

Page

6 of 8

Client

ONIZUKA APB

Location

SUNNYVALE, CA

Prepared By

S. J. J.

Date

12-3

Checked By

N/A

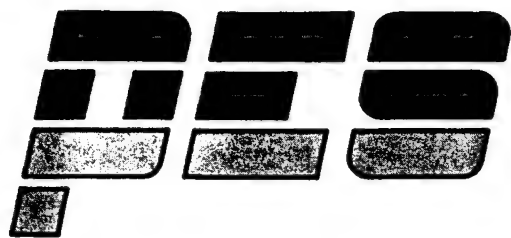
Date

-

Sheet Title

RUN 3

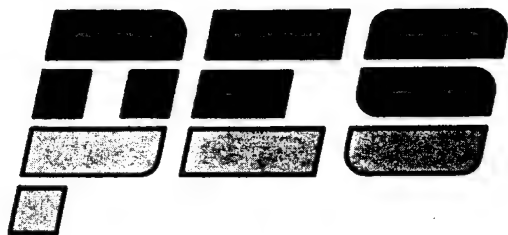
TIME	NO _x	CO	CO ₂	O ₂	NOTES
--	0.1	0.7	-0.1	0.0	ZERO +0.01
--	44.6	75.2	3.8	19.0	H-SPAN 3.9%
--	23.3	50.5	2.1	11.0	M-SPAN --
--	10.3	--	--	--	L-SPAN --
--	44.0	75.0	--	18.9	Bias --
13:46	36.4	65.5	2.2	17.4	START AT R 2 SE
13:47	36.5	65.5	2.2	17.5	
13:48	36.6	65.5	2.2	17.5	
13:49	36.6	65.6	2.2	17.5	
13:50	36.7	65.6	2.2	17.5	
13:51	36.7	65.7	2.2	17.5	
13:52	36.6	65.6	2.2	17.5	
13:53	36.6	65.7	2.2	17.4	
13:54	36.6	65.6	2.2	17.4	
13:55	36.7	65.6	2.2	17.4	(10 MIN)
13:56	36.8	65.8	2.2	17.4	
13:57	36.6	65.9	2.2	17.4	
13:58	36.6	65.6	2.2	17.4	
13:59	36.6	65.5	2.2	17.5	
14:00	36.6	65.4	2.2	17.5	
14:01	36.5	65.3	2.2	17.5	
14:02	36.5	65.5	2.2	17.5	
14:03	36.6	65.6	2.2	17.5	
14:04	36.6	65.6	2.2	17.5	
14:05	36.5	65.5	2.2	17.5	(20 MIN) MAND TO R 3 SE



PACIFIC ENVIRONMENTAL SERVICES, INC.

Project No. F028.000		Page 7 of 8	
Client ONIZUKA AFB			
Location SUNNYVALE, CA			
Prepared By SWH	Date 12-3	Checked By N/A	Date -
Sheet Title Run 3			

TIME	NO _x	CO	CO ₂	O ₂	NOTES
14:06	36.3	65.5	2.2	17.5	
14:07	36.2	65.1	2.2	17.5	
14:08	36.3	65.3	2.2	17.5	
14:09	36.3	65.5	2.2	17.5	
14:10	36.3	65.6	2.2	17.5	
14:11	36.3	65.4	2.2	17.5	
14:12	36.3	65.5	2.2	17.5	
14:13	36.4	65.5	2.2	17.5	
14:14	36.5	65.4	2.2	17.5	
14:15	36.4	65.5	2.2	17.5	(30 MIN)
14:16	36.3	65.4	2.2	17.5	
14:17	36.5	65.5	2.2	17.5	
14:18	36.7	65.6	2.2	17.5	
14:19	36.7	65.7	2.2	17.5	
14:20	36.5	65.8	2.2	17.5	
14:21	36.5	65.6	2.2	17.5	
14:22	36.7	65.5	2.2	17.5	
14:23	36.6	65.5	2.2	17.5	
14:24	36.6	65.5	2.2	17.5	
14:25	36.4	65.5	2.2	17.5	(40 MIN) MOVED to R 4 SE
14:26	36.4	65.5	2.2	17.5	
14:27	36.3	65.5	2.2	17.5	
14:28	36.2	65.5	2.2	17.5	
14:29	36.2	65.5	2.2	17.5	
14:30	36.0	63.7	2.1	17.6	PROBE MOVED FOR PM ₁₀
14:31	36.2	65.6	2.2	17.5	
14:32	36.0	65.6	2.2	17.5	
14:33	36.3	65.8	2.2	17.5	
14:34	36.4	65.6	2.2	17.5	
14:35	36.5	65.8	2.2	17.5	(50 MIN)

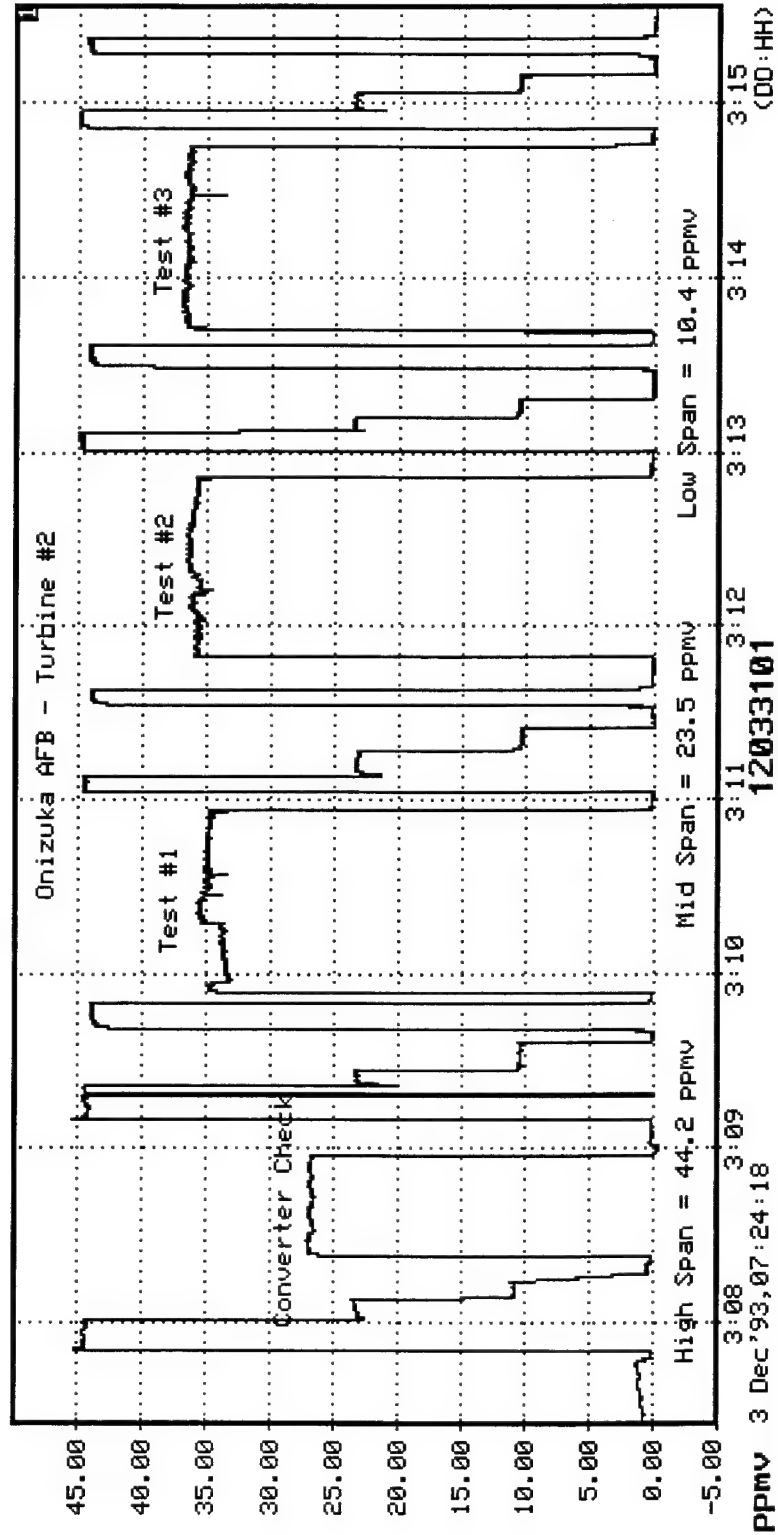


PACIFIC ENVIRONMENTAL SERVICES, INC.

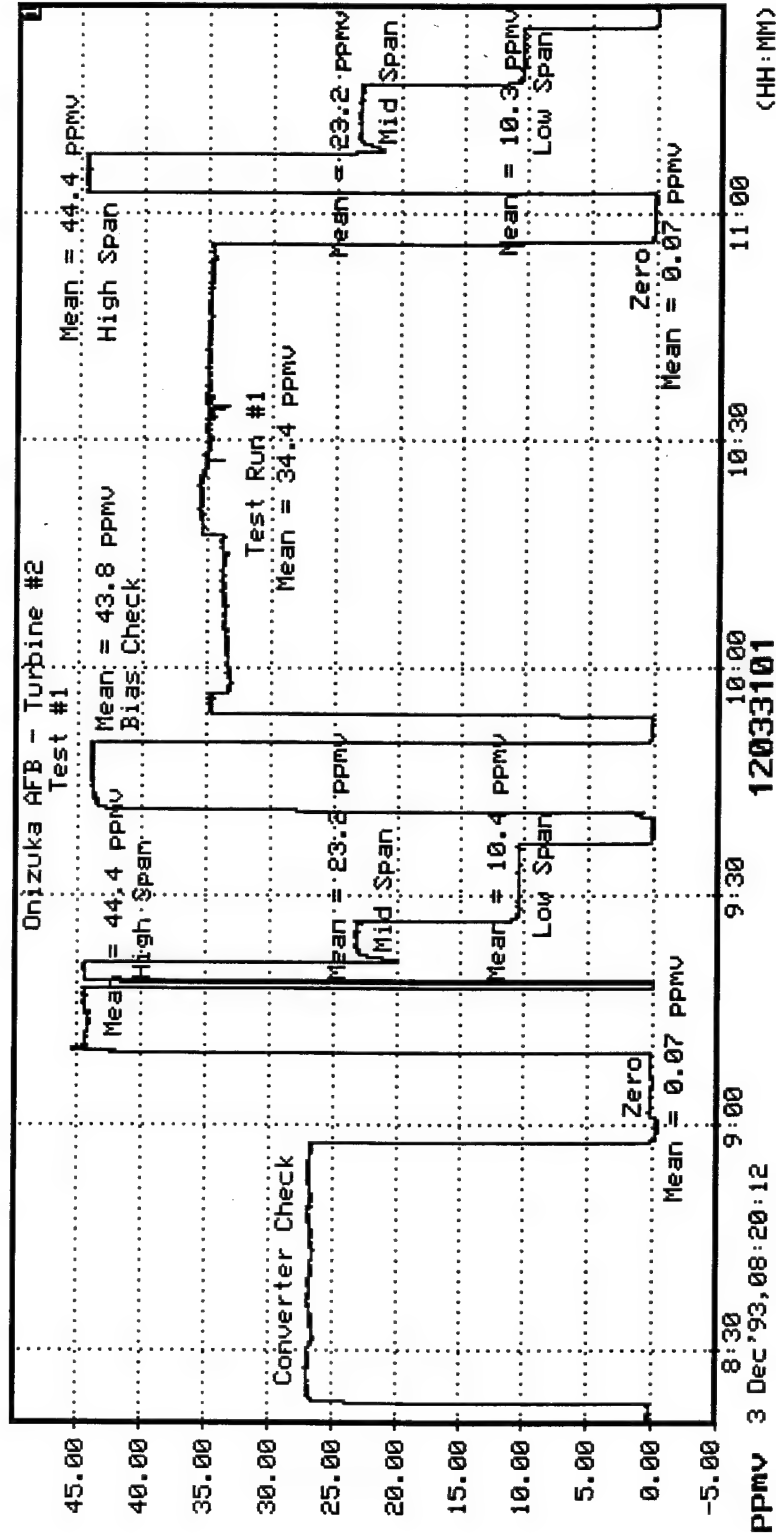
Project No. F028,000		Page 8 of 8	
Client ONIZUKA AFB			
Location SUNNYVALE, CA			
Prepared By S. Smith	Date 12-3	Checked By W/A	Sheet Title RUN 3

TIME	NO _x	CO	CO ₂	O ₂	NOTES
14:36	36.5	65.9	2.2	17.5	
14:37	36.5	66.0	2.2	17.5	
14:38	36.4	65.8	2.2	17.5	
14:39	36.4	66.1	2.2	17.5	
14:40	36.4	66.2	2.2	17.4	
14:41	36.2	66.3	2.2	17.5	
14:42	36.2	66.2	2.2	17.5	
14:43	36.3	66.0	2.2	17.5	
14:44	36.3	66.2	2.2	17.5	
14:45	36.2	66.4	2.2	17.5	(60 MIN)
--	0.0	0.7	0.0	0.0	ZERO
--	44.8	75.1	3.9	19.1	H-SPAN
--	23.3	50.5	2.2	11.0	H-SPAN
--	10.4	--	--	--	L-SPAN
--	43.7	75.0	2.2	19.0	BIDS
15:-	44.1				END OF TEST.

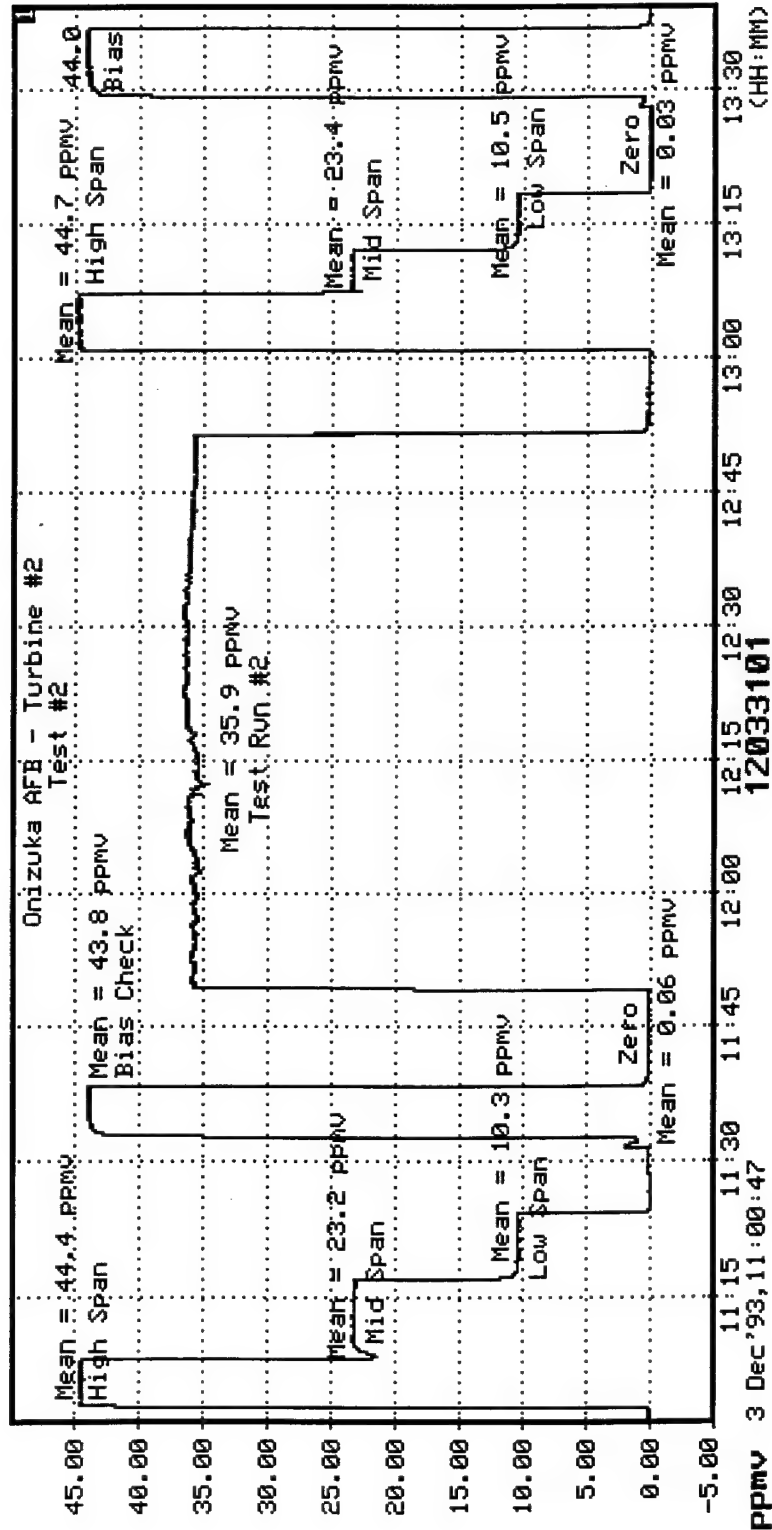
N O X



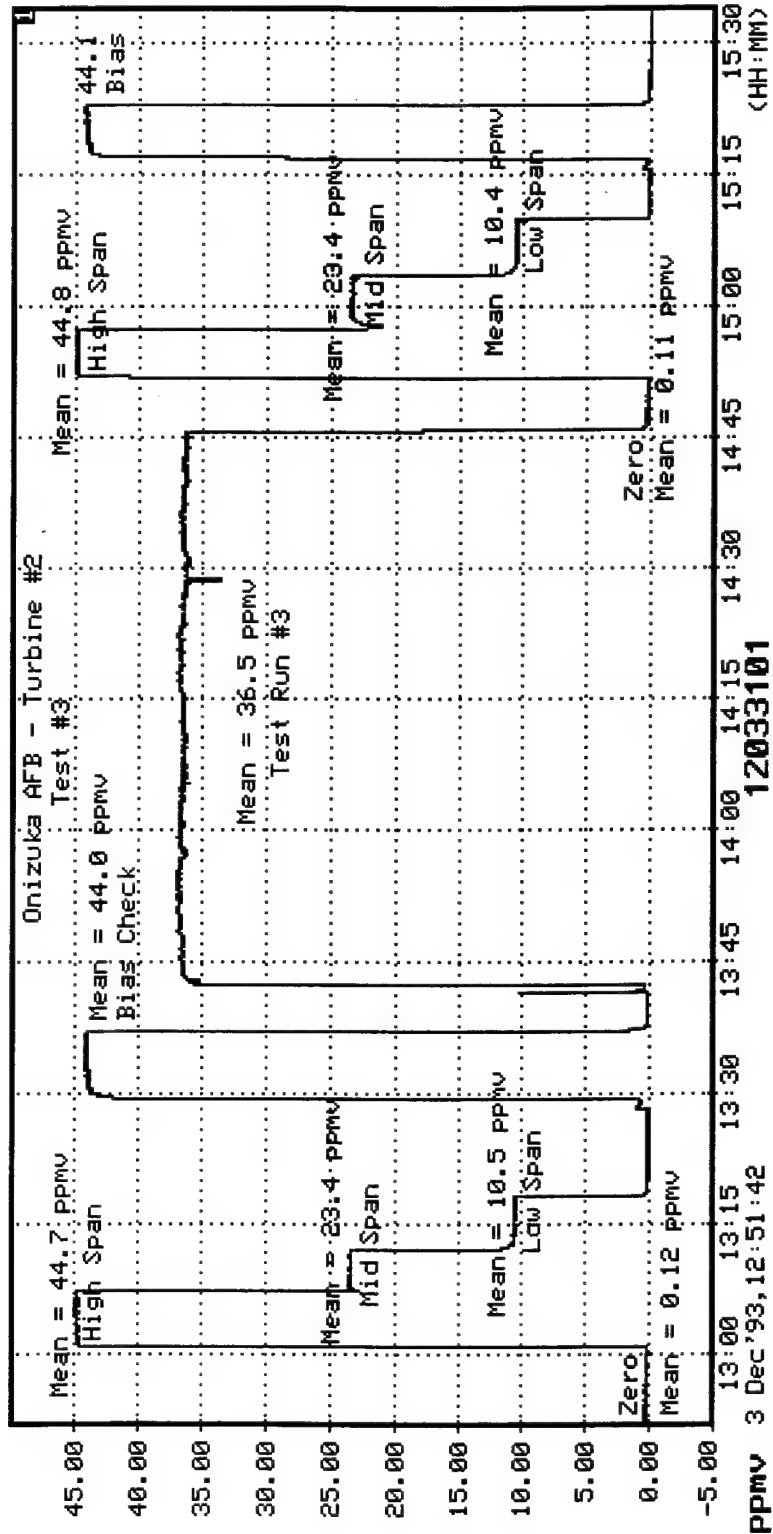
N O X



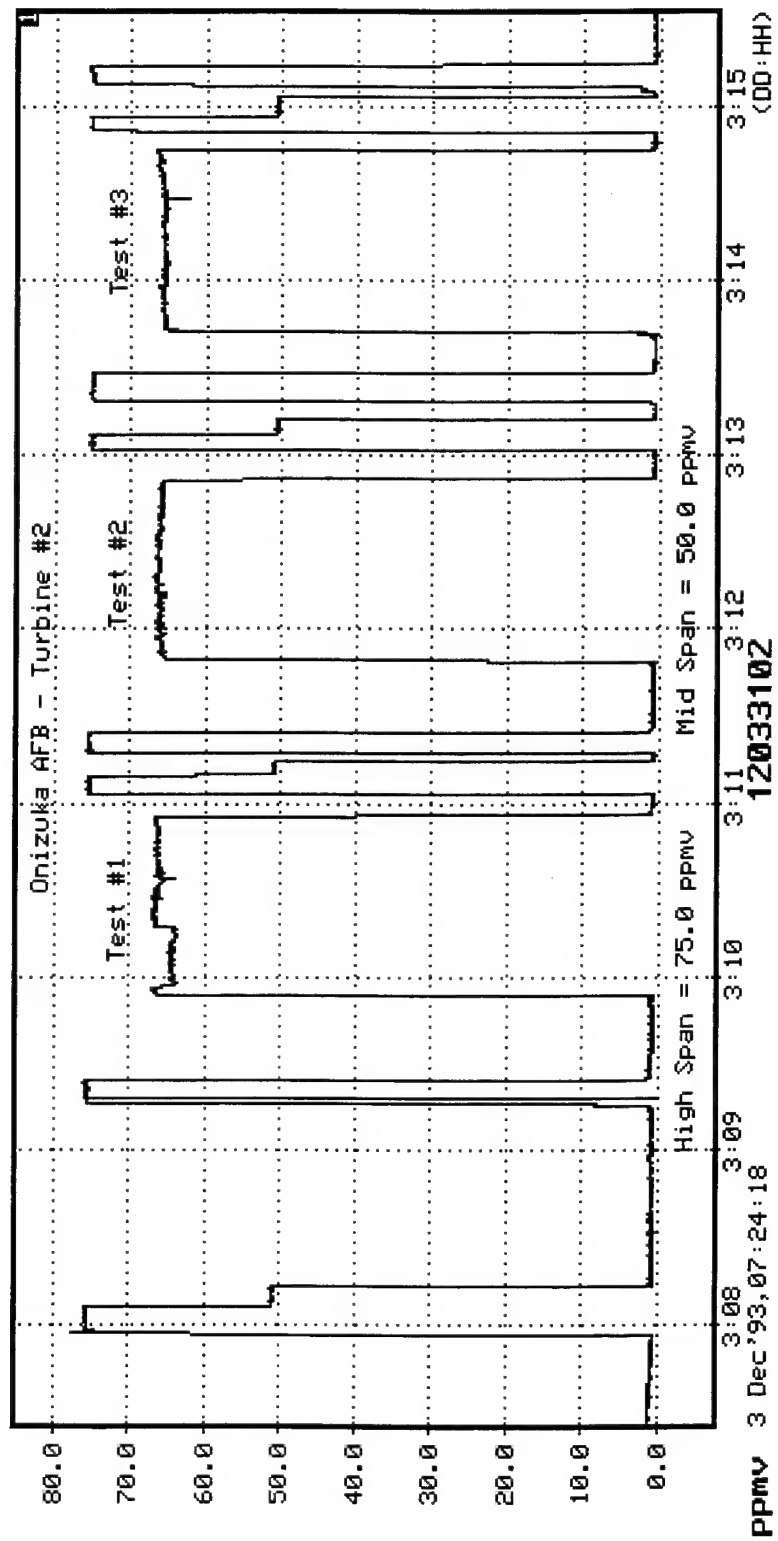
NOX

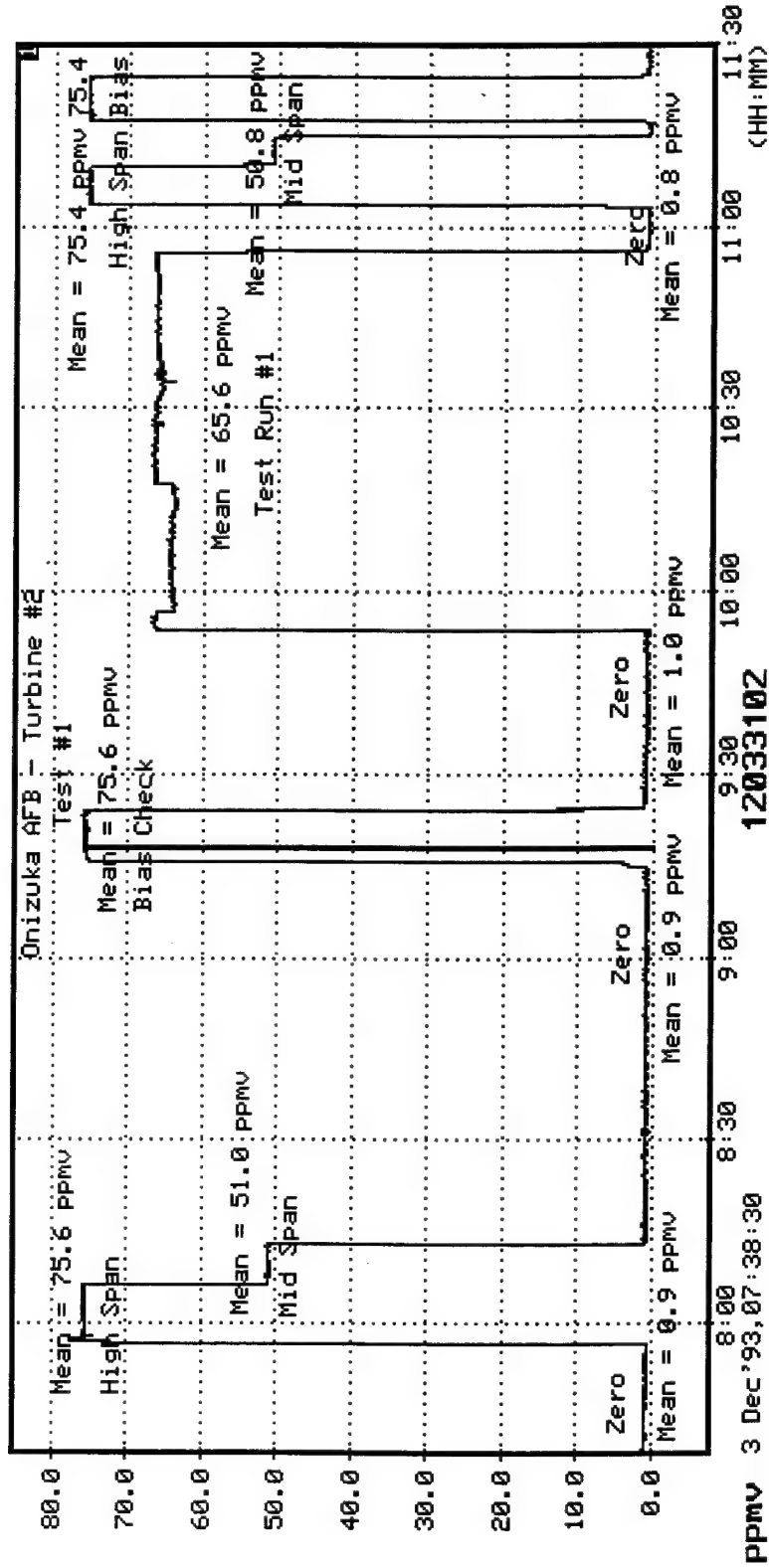


N O X

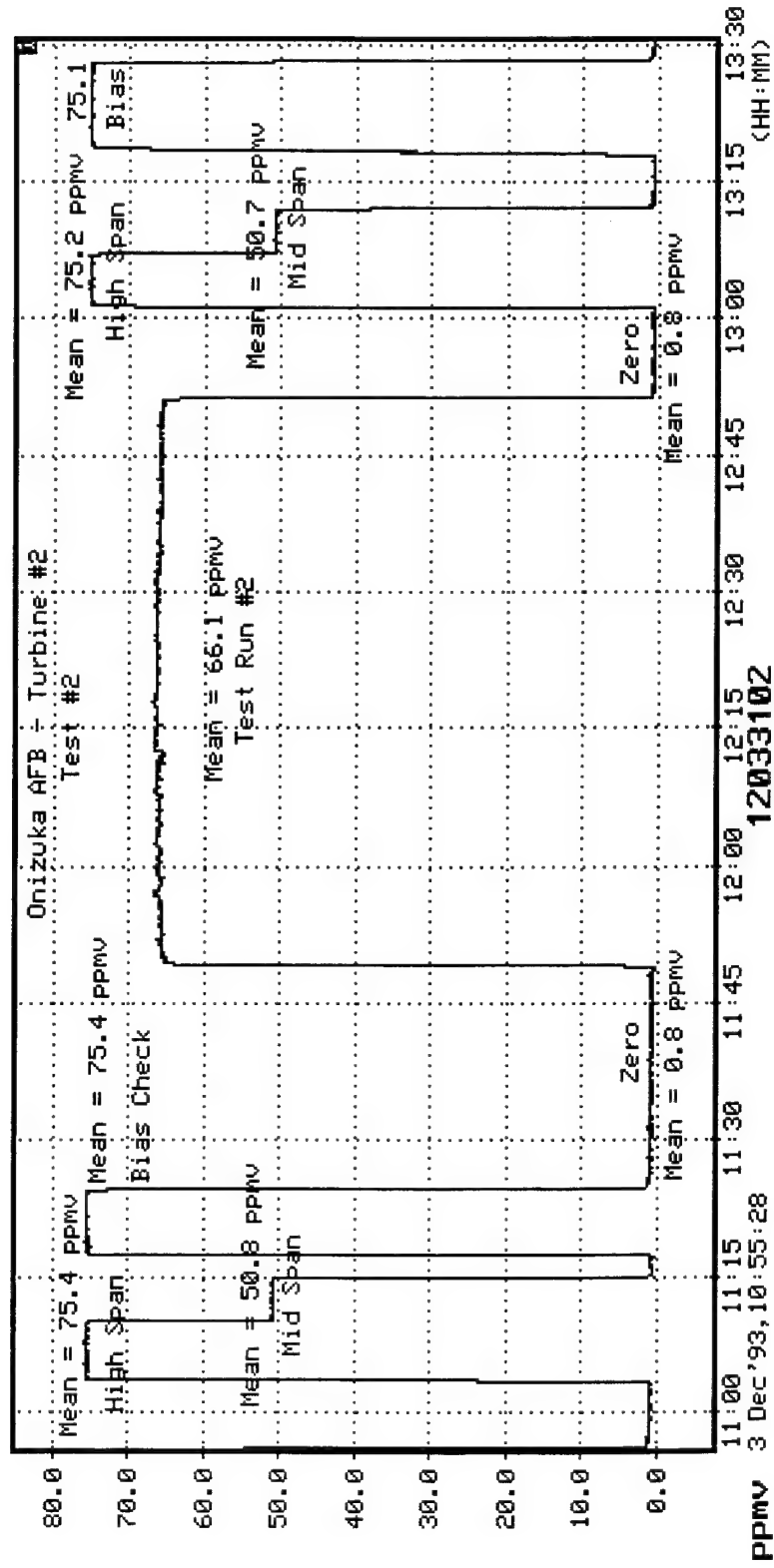


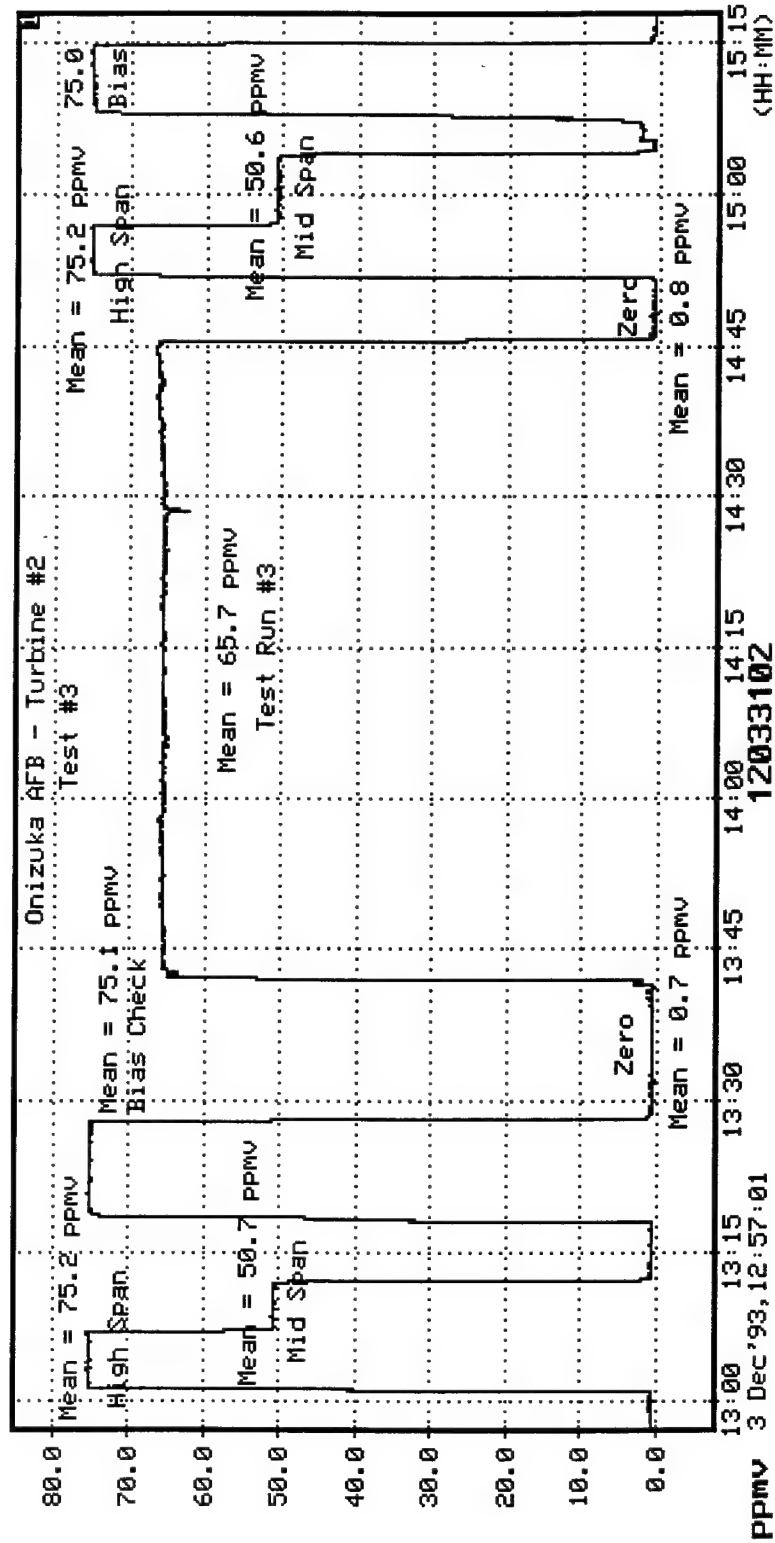
C
0



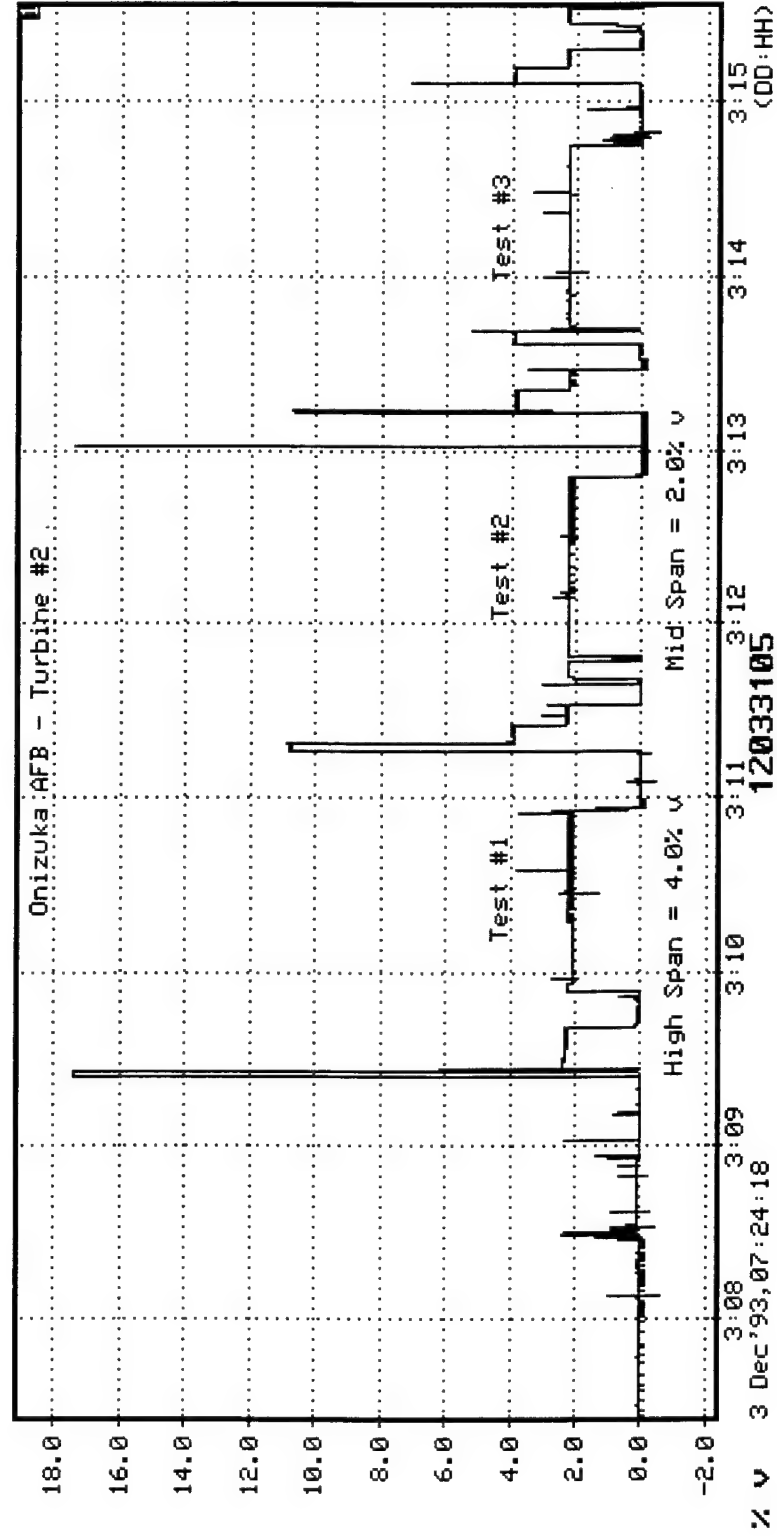


C
0





C
0
2



Onizuka: AFB - Turbine #2

Test #1

Test Run #1

Test Run #2

Zero

Mid Span

High Span

Mean = 0.0%

Mean = 2.2%

Mean = 2.3%

Mean = 3.9%

Bias

9:15 9:30 9:45 10:00 10:15 10:30 10:45 11:00 11:15 11:30 11:45

3 Dec '93, 09:11:49

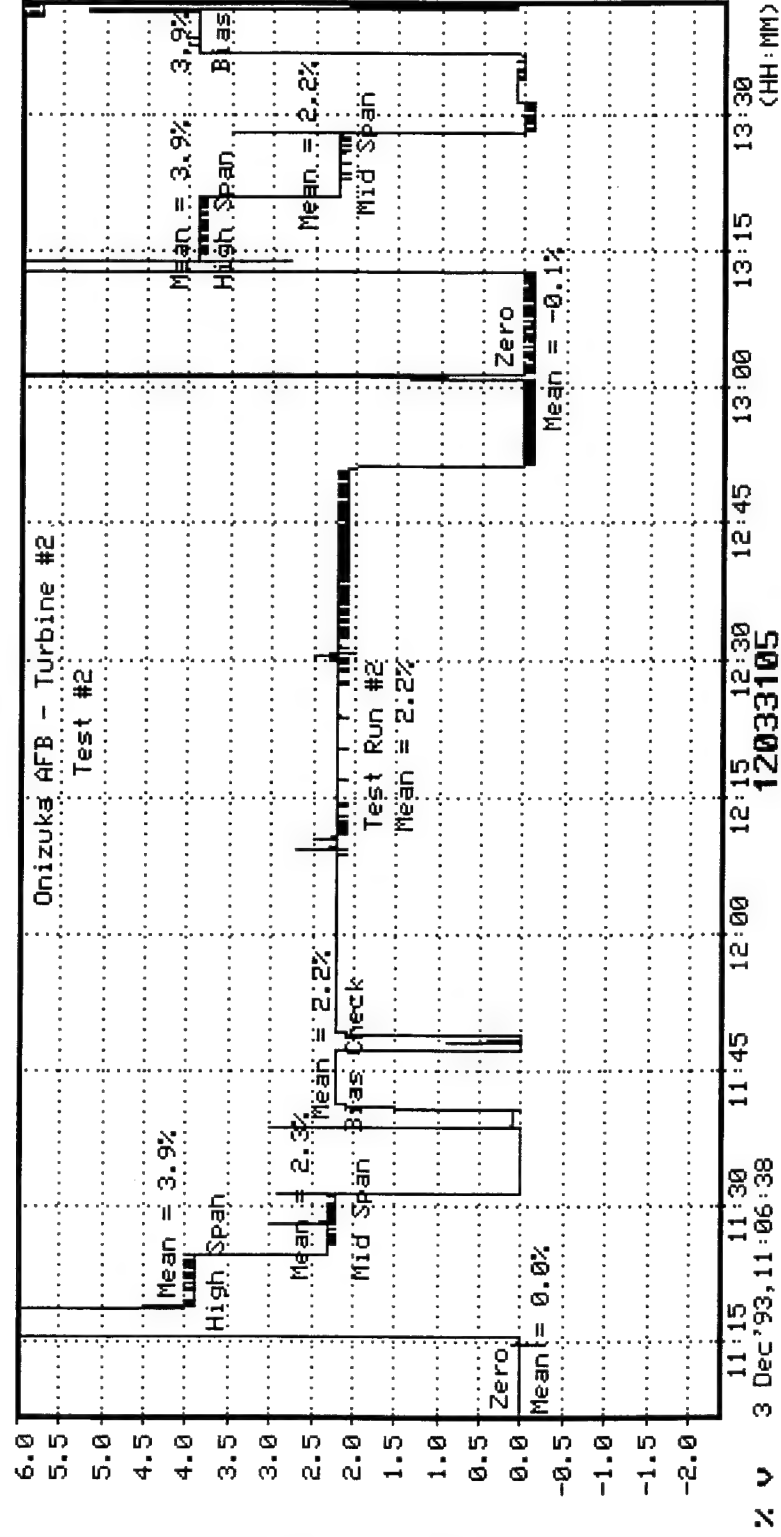
12033105

(HH:MM)

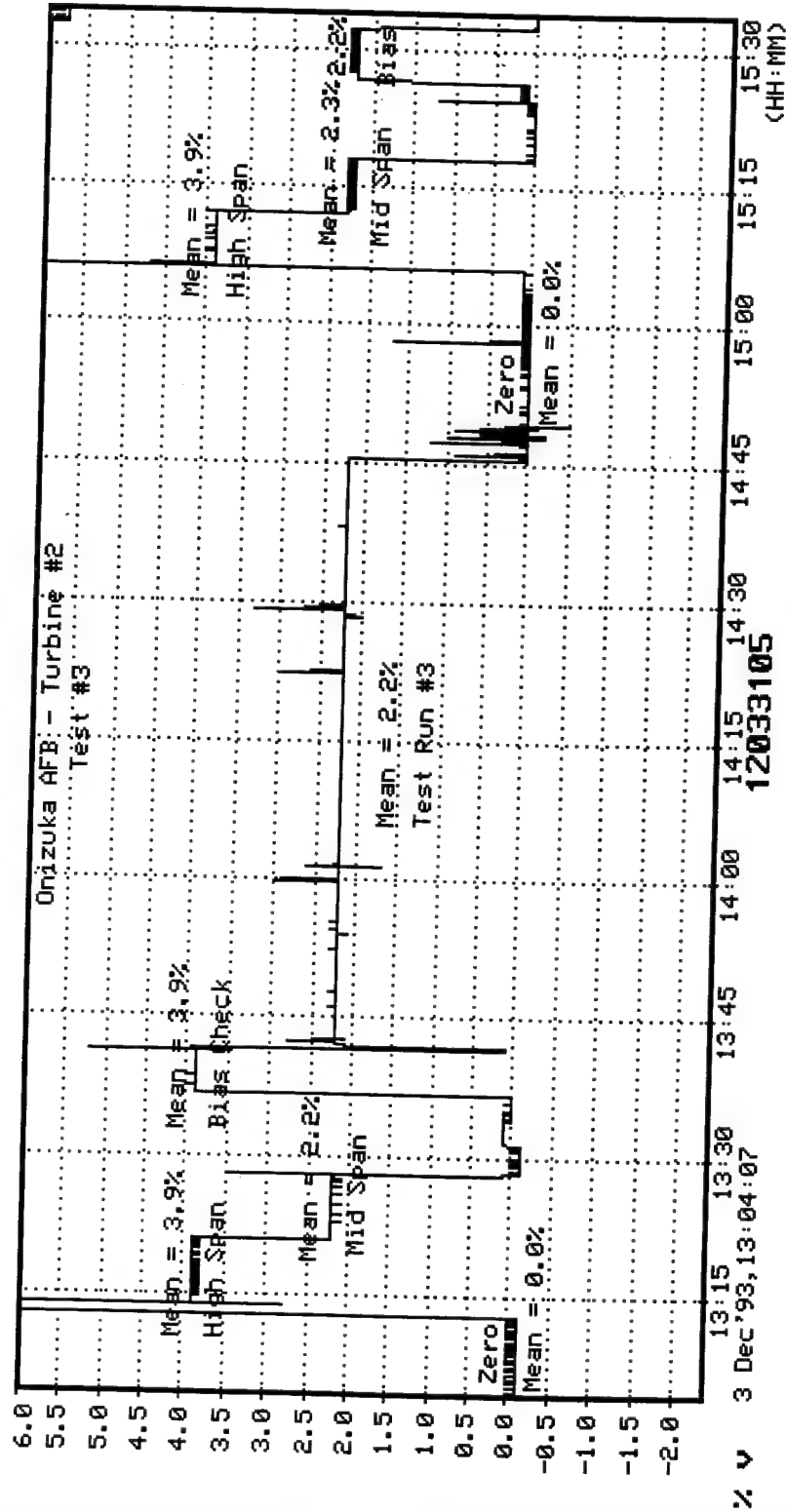
10:30
12033105

CH:MM
11:43

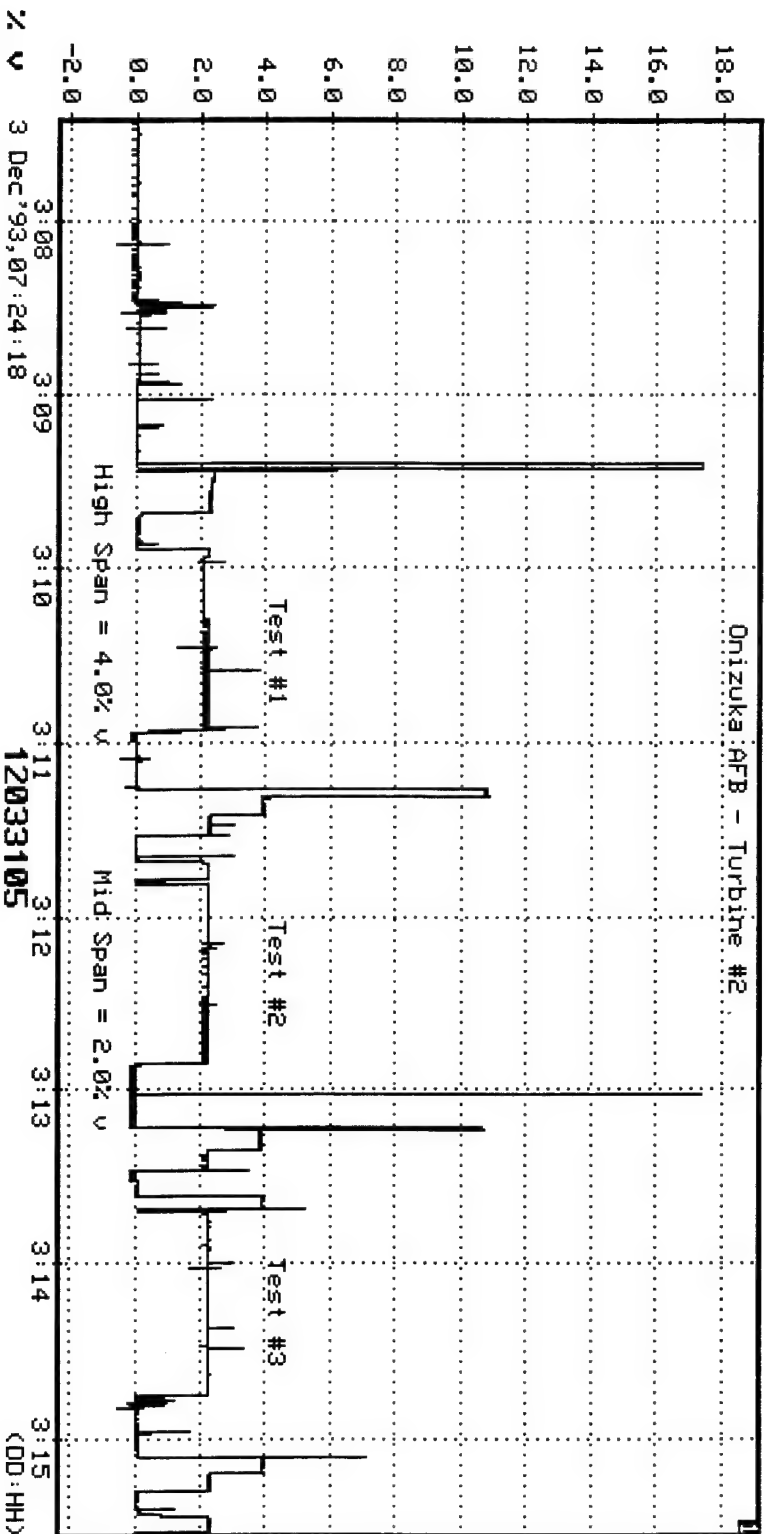
C
0
2

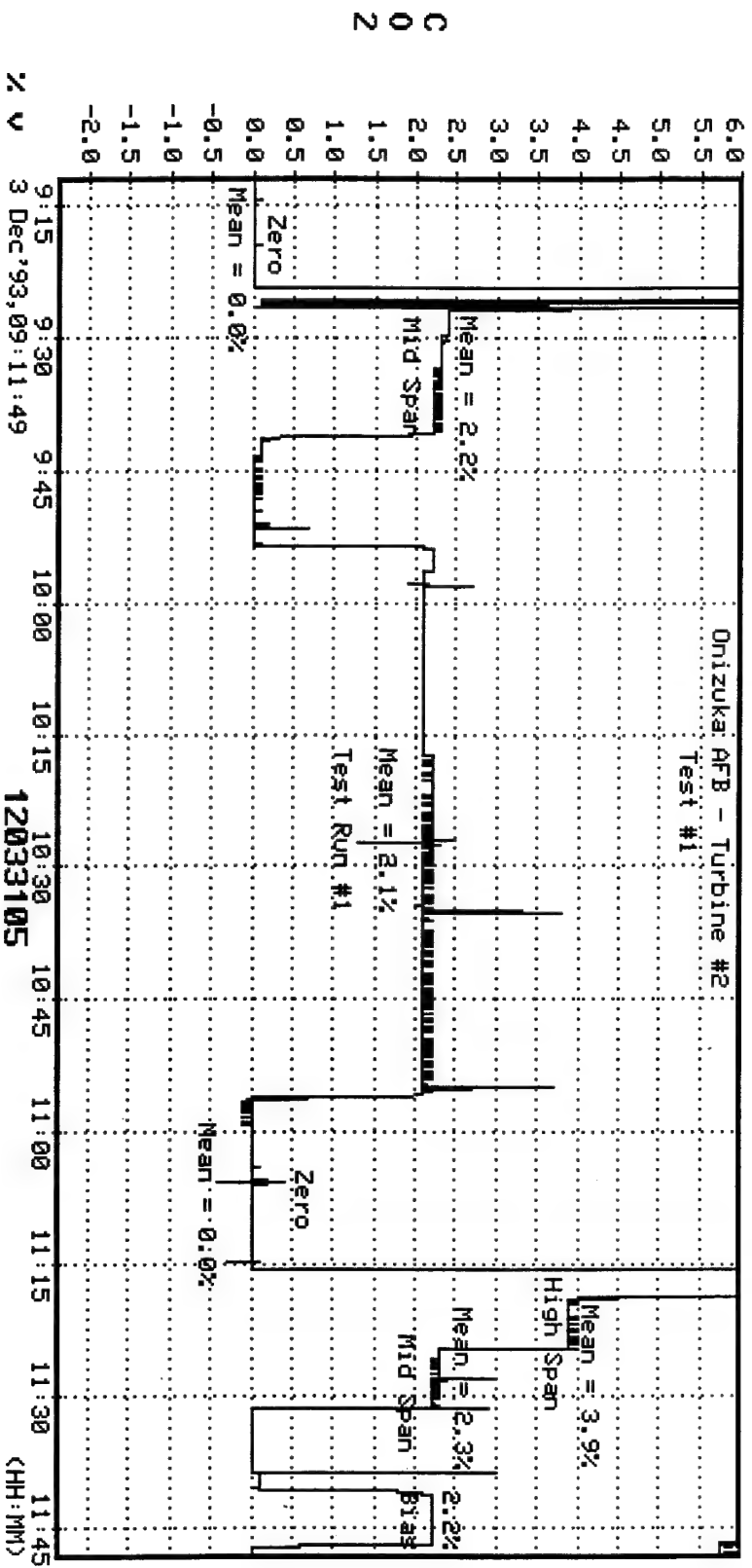


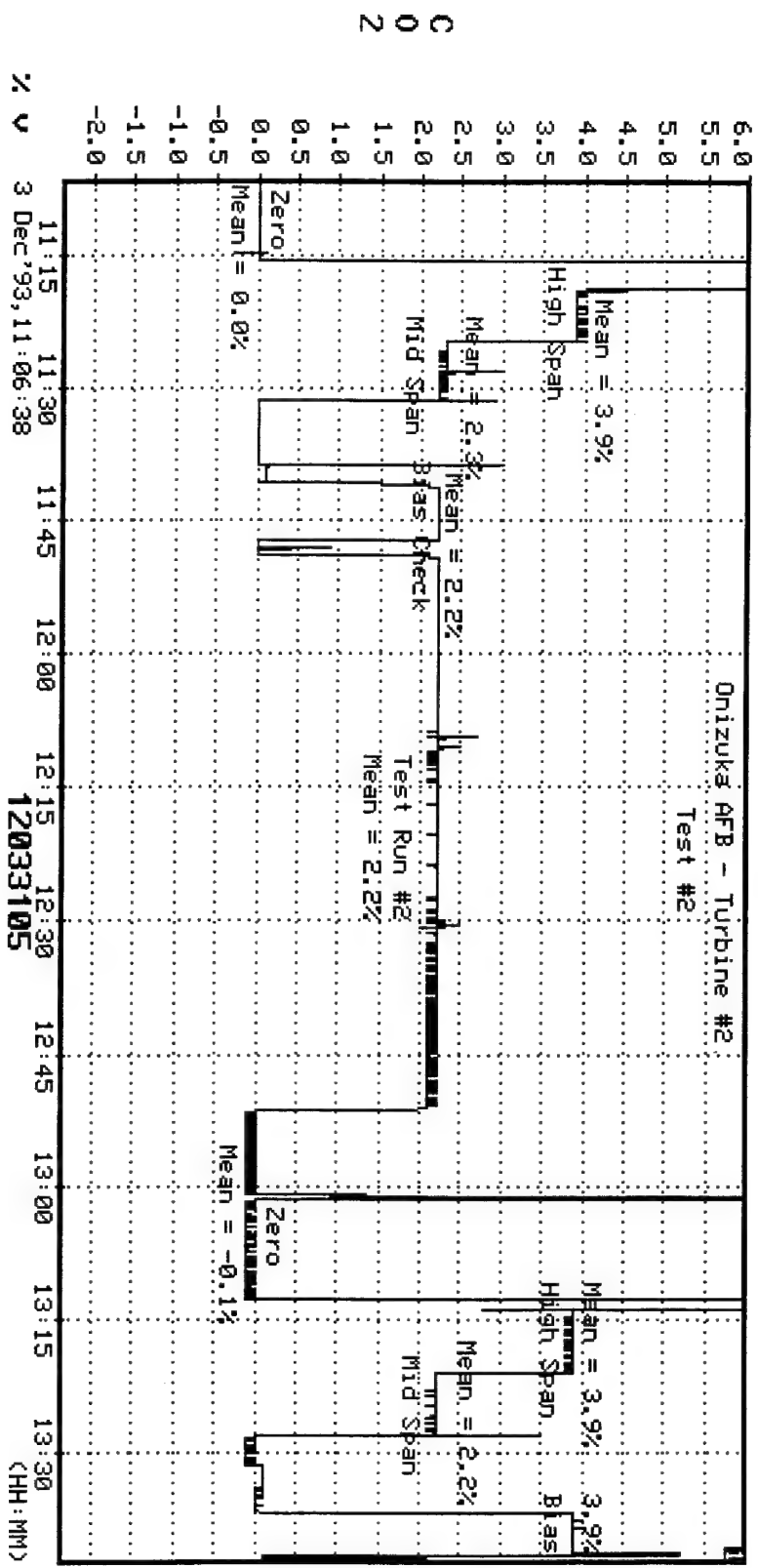
C 0 2



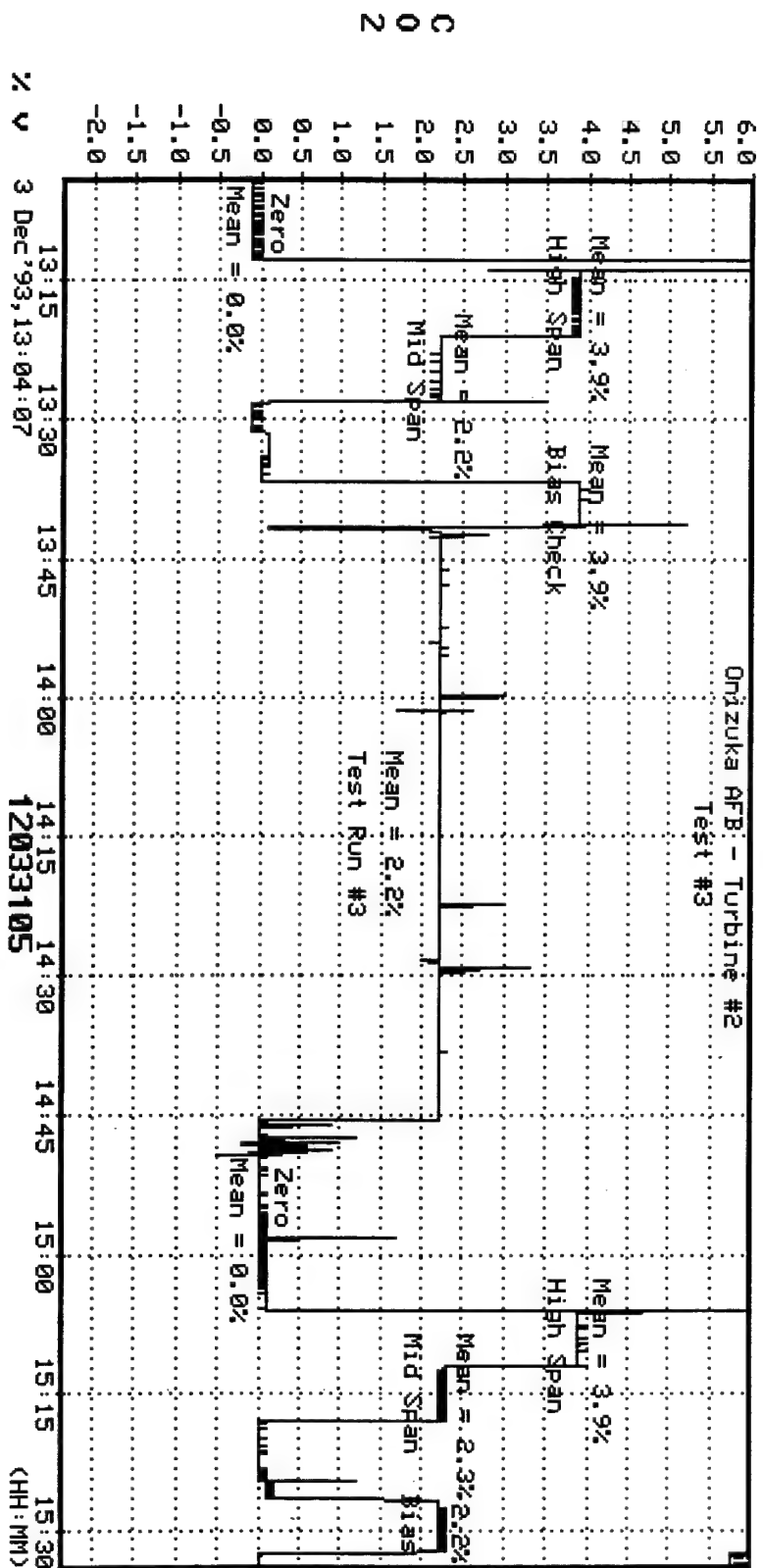
C
0
2



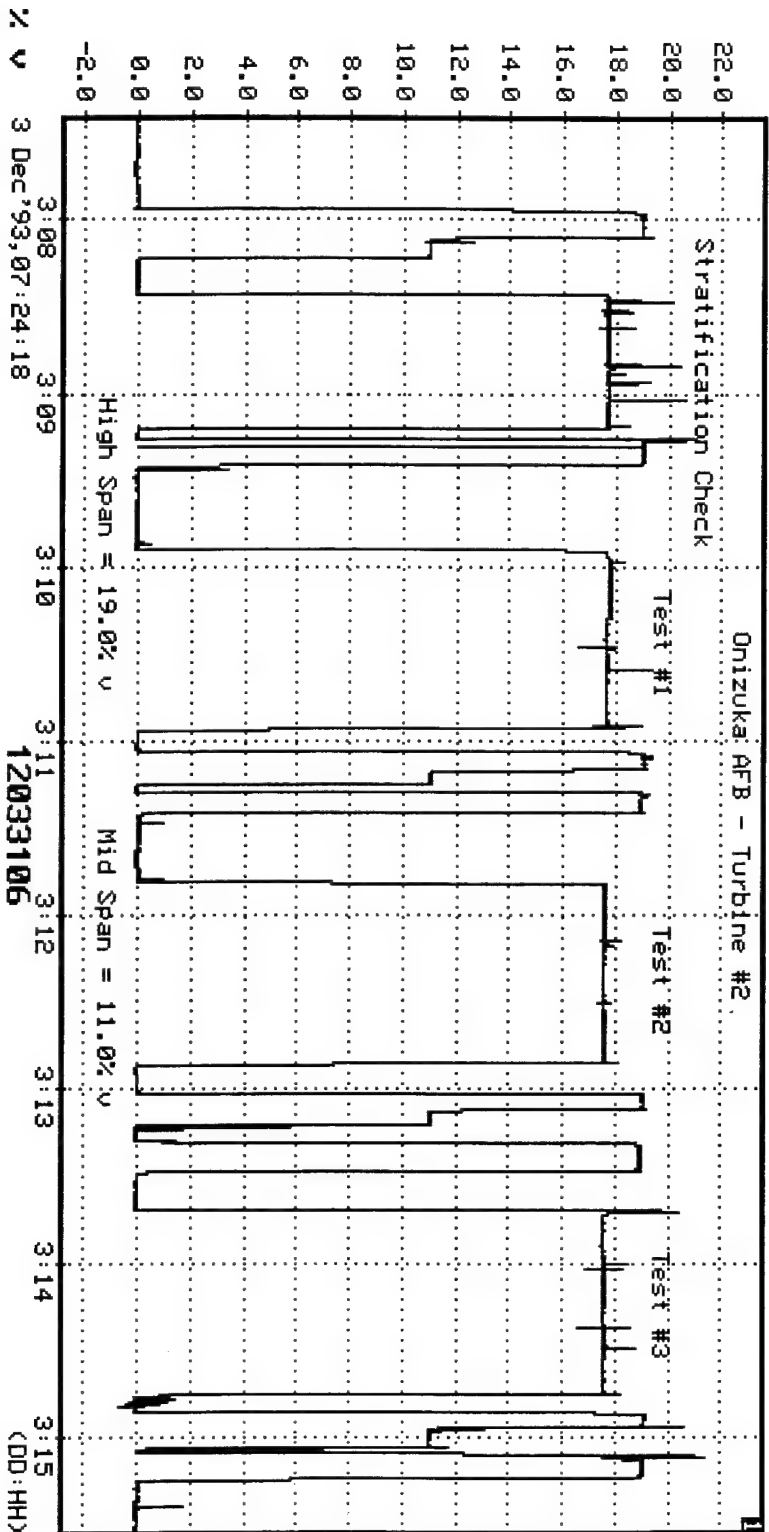


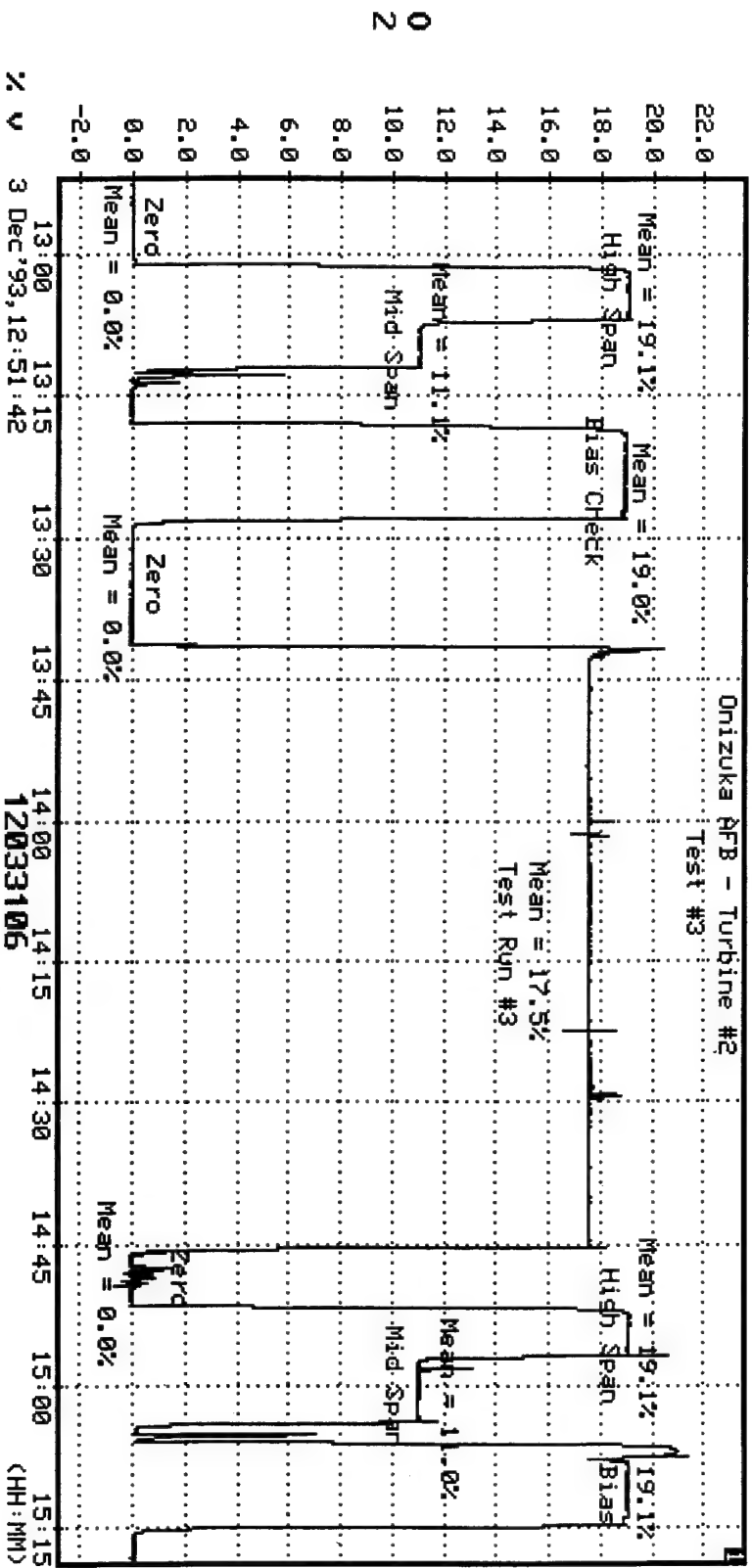


C
0
2



C
0
2



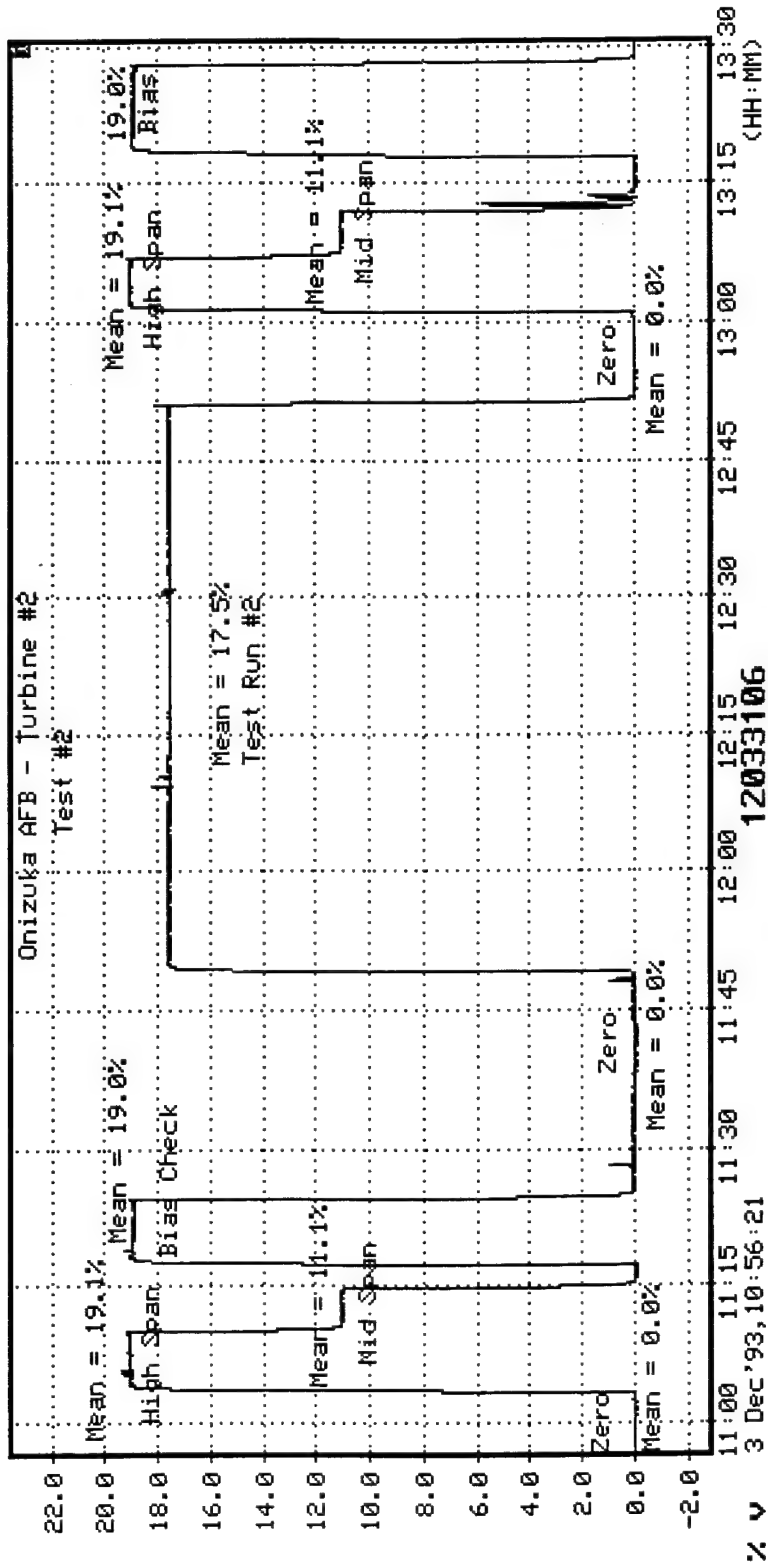


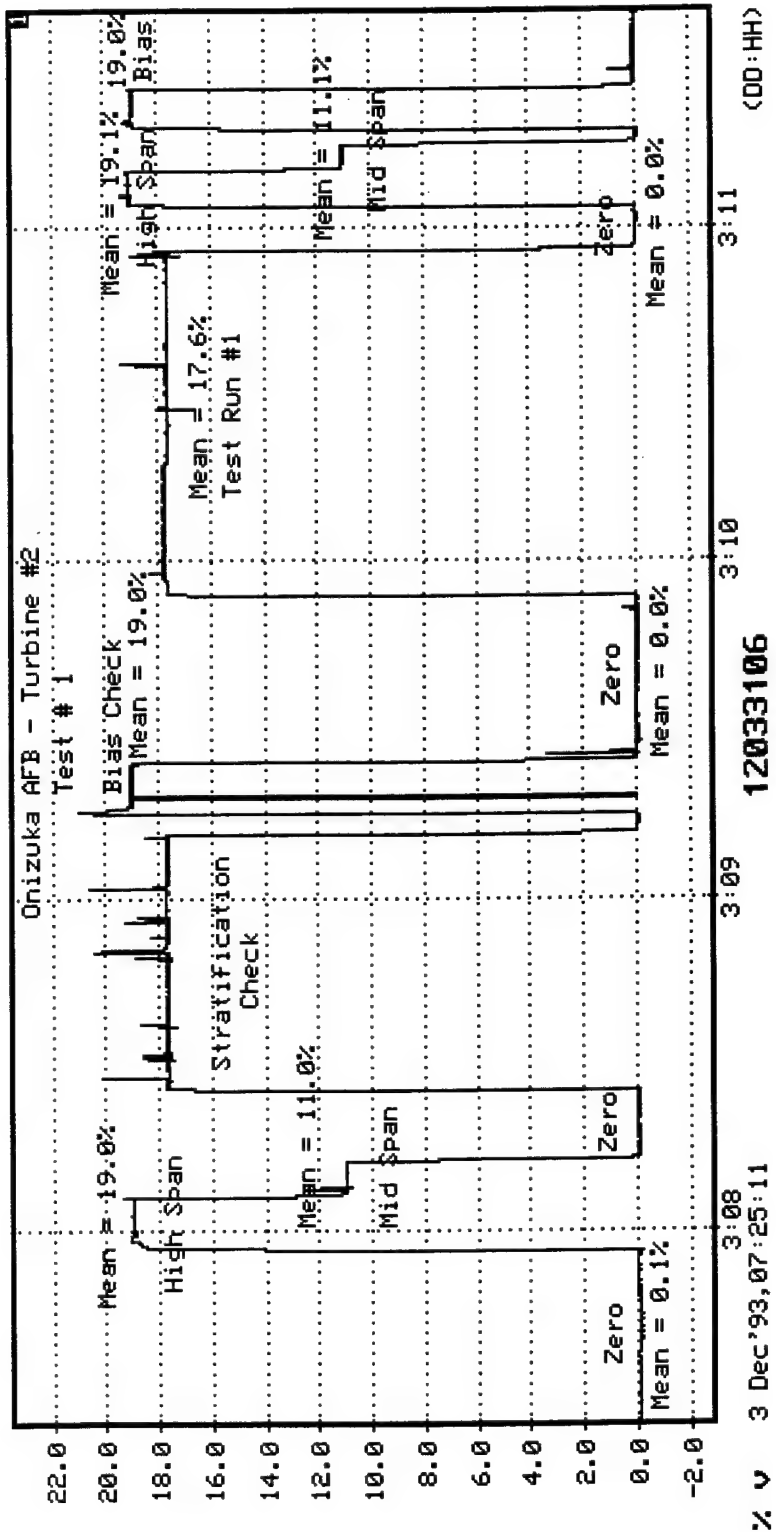


PACIFIC ENVIRONMENTAL SERVICES, INC.

Project No.	F028	Page	1	of	4
Client	ONIZUKA AFB				
Location	TURBINE #2 EXHAUST				
Prepared By	Date	Checked By	Date	Sheet Title	
STB	2/5			CONTINUOUS MONITORING QA/QC	

NOx	SPAN VALVE PPMV	PRE-TEST		POST-TEST		DRIFT %F.S.
		RESPONSE PPMV	CAL ERROR %F.S.	RESPONSE PPMV	CAL ERROR %F.S.	
TEST #1						
ZERO	0.00	0.07	0.14	0.07	0.14	0.00
LOW SPAN	10.4	10.4	0.00	10.3	-0.20	-0.20
MID SPAN	23.5	23.2	-0.60	23.2	-0.60	0.00
HIGH SPAN	44.2	44.4	0.40	44.4	0.40	0.00
BIAS	44.2	43.8	-0.80	-	-	-
TEST #2						
ZERO	0.00	0.06	0.12	0.03	0.06	-0.06
LOW SPAN	10.4	10.3	-0.20	10.5	0.20	0.40
MID SPAN	23.5	23.2	-0.60	23.4	-0.20	0.40
HIGH SPAN	44.2	44.4	0.40	44.7	1.00	0.60
BIAS	44.2	43.8	-0.80	-	-	-
TEST #3						
ZERO	0.00	0.12	0.24	0.11	0.22	-0.02
LOW SPAN	10.4	10.5	0.20	10.4	0.00	-0.20
MID SPAN	23.5	23.4	-0.20	23.4	-0.20	0.00
HIGH SPAN	44.2	44.7	1.00	44.8	1.20	0.20
BIAS	44.2	44.0	-0.40	44.1	-0.20	0.20





0 2

% v 3 Dec'93, 07:25:11

12033106

<00:HH>



PACIFIC ENVIRONMENTAL SERVICES, INC.

Project No.	F028	Page	2	of	4
Client	ONIZUKA AFB				
Location	TURBINE #2 EXHAUST				

Prepared By	Date	Checked By	Date	Sheet Title
SPB	2/5			CONTINUOUS MONITORING QA/QC

CO	SPAN VALVE PPMV	PRE-TEST		POST-TEST		DRIFT %F.S.
		RESPONSE PPMV	CAL ERROR %F.S.	RESPONSE PPMV	CAL ERROR %F.S.	
TEST #1						
ZERO	0.00	0.9	0.90	0.8	0.80	-0.10
LOW SPAN	—	—	—	—	—	—
MID SPAN	50.0	51.0	1.00	50.8	0.80	-0.20
HIGH SPAN	75.0	75.6	0.60	75.4	0.40	-0.20
BIAS	75.0	75.6	0.60	—	—	—
TEST #2						
ZERO	0.00	0.8	0.80	0.8	0.80	0.00
LOW SPAN	—	—	—	—	—	—
MID SPAN	50.0	50.8	0.80	50.7	0.70	-0.10
HIGH SPAN	75.0	75.4	0.40	75.2	0.20	-0.20
BIAS	75.0	75.4	0.40	—	—	—
TEST #3						
ZERO	0.00	0.7	0.70	0.8	0.80	0.10
LOW SPAN	—	—	—	—	—	—
MID SPAN	50.0	50.7	0.70	50.6	0.60	-0.10
HIGH SPAN	75.0	75.2	0.20	75.2	0.20	0.00
BIAS	75.0	75.1	0.10	75.0	0.00	—



PACIFIC ENVIRONMENTAL SERVICES, INC.

Project No.

F028

Page

3

of

4

Client

ONIZUKA AFB

Location

TURBINE #2 EXHAUST

Prepared By

SJB

Date

7/5

Checked By

Date

Sheet Title

CONTINUOUS MONITORING QA/QC

	SPAN VALVE PPMV	PRE-TEST		POST-TEST		DRIFT %F.S.
		RESPONSE PPMV	CAL ERROR %F.S.	RESPONSE PPMV	CAL ERROR %F.S.	
CO ₂						
TEST #1						
ZERO	0.00	0.0	0.00	0.0	0.0	0.00
LOW SPAN	-	-	-	-	-	-
MID SPAN	2.0	2.2	.0	2.3	3.0	1.00
HIGH SPAN	4.0	-	-	3.9	-1.0	-
BIAS	2.0	-	-	2.2	2.0	-
TEST #2						
ZERO	0.00	0.0	0.00	-0.1	-1.0	
LOW SPAN	-	-	-	-	-	-
MID SPAN	2.0	2.3	3.0	2.2	2.0	
HIGH SPAN	4.0	3.9	-1.0	3.9	-1.0	
BIAS	4.0	-	-	3.9	-1.0	-
TEST #3						
ZERO	0.00	0.0	0.00	0.0	0.00	0.00
LOW SPAN	-	-	-	-	-	-
MID SPAN	2.0	2.2	2.0	2.3	3.0	1.00
HIGH SPAN	4.0	3.9	-1.0	3.9	-1.0	0.00
BIAS	2.0	-	-	2.2	2.0	-



PACIFIC ENVIRONMENTAL SERVICES, INC.

Project No.

F028

Page

4

of

4

Client

ONIZUKA AFB

Location

TURBINE #2 EXHAUST

Prepared By

SJD

Date

7/5

Checked By

Date

Sheet Title

CONTINUOUS MONITORING QA/QC

PRE-TEST

POST-TEST

<u>O₂</u>	<u>SPAN VALVE PPMV</u>	<u>RESPONSE PPMV</u>	<u>CAL ERROR %F.S.</u>	<u>RESPONSE PPMV</u>	<u>CAL ERROR %F.S.</u>	<u>DRIFT %F.S.</u>
TEST #1						
ZERO	0.00	0.1	0.40	0.0	0.00	-0.40
LOW SPAN	-	-	-	-	-	-
MID SPAN	11.0	11.0	0.00	11.1	0.40	0.40
HIGH SPAN	19.0	19.0	0.00	19.1	0.40	0.40
BIAS	19.0	19.0	0.00	-	-	-
TEST #2						
ZERO	0.00	0.0	0.00	0.0	0.00	0.00
LOW SPAN	-	-	-	-	-	-
MID SPAN	11.0	11.1	0.40	11.1	0.40	0.00
HIGH SPAN	19.0	19.1	0.40	19.1	0.40	0.00
BIAS	19.0	19.0	0.00	-	-	-
TEST #3						
ZERO	0.00	0.0	0.00	0.0	0.00	0.00
LOW SPAN	-	-	-	-	-	-
MID SPAN	11.0	11.1	0.40	11.0	0.00	-0.40
HIGH SPAN	19.0	19.1	0.40	19.1	0.40	0.00
BIAS	19.0	19.0	0.00	19.1	0.40	-

DAILY POWER PLANT OPERATING LOG - (TURBINE - BOILER)

ENGINE SERIAL NUMBER

20654

ENGINE MFR

SOLAR

MODEL

T-10215-21

HP

1100

KW

750

DATE

3 Dec 83

ENGINE SERIAL NUMBER

20636

GENERATOR MFR

ELECTRIC MACHINERY

MODEL

REMAC II

VOLTAGE

4160

KW

750

DATE

3 Dec 83

ENGINE SERIAL NUMBER

20636

TURBINE AND GENERATOR

TIME	KW	KVAR	AMPS	AMPS	AMPS	T-7	T-6	PCD	LOP	LOT	LO	INLET	PS	P
MON	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0100	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0200	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0300	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0400	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0500	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0600	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0700	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0800	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0900	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1000	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1100	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1200	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1300	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1400	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1500	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1600	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1700	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1800	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1900	140	180	72	71	74	140	180	72	71	74	140	180	72	71
2000	140	180	72	71	74	140	180	72	71	74	140	180	72	71
2100	140	180	72	71	74	140	180	72	71	74	140	180	72	71
2200	140	180	72	71	74	140	180	72	71	74	140	180	72	71
2300	140	180	72	71	74	140	180	72	71	74	140	180	72	71

ENGINE OPERATING HOURS

PREVIOUS TOTAL	30S	MDS	DAYS	SWINGS
140724				
TOTAL TODAY				
TOTAL TO DATE				

3100 down 1500

72

TURBINE AND GENERATOR

TIME	KW	KVAR	AMPS	AMPS	AMPS	T-7	T-6	PCD	LOP	LOT	LO	INLET	PS	P
MON	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0100	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0200	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0300	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0400	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0500	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0600	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0700	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0800	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0900	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1000	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1100	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1200	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1300	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1400	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1500	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1600	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1700	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1800	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1900	140	180	72	71	74	140	180	72	71	74	140	180	72	71
2000	140	180	72	71	74	140	180	72	71	74	140	180	72	71
2100	140	180	72	71	74	140	180	72	71	74	140	180	72	71
2200	140	180	72	71	74	140	180	72	71	74	140	180	72	71
2300	140	180	72	71	74	140	180	72	71	74	140	180	72	71

ENGINE OPERATING HOURS

PREVIOUS TOTAL	30S	MDS	DAYS	SWINGS
151256				
TOTAL TODAY				
TOTAL TO DATE				

0450 STARTED

72

TURBINE AND GENERATOR

TIME	KW	KVAR	AMPS	AMPS	AMPS	T-7	T-6	PCD	LOP	LOT	LO	INLET	PS	P
MON	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0100	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0200	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0300	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0400	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0500	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0600	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0700	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0800	140	180	72	71	74	140	180	72	71	74	140	180	72	71
0900	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1000	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1100	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1200	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1300	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1400	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1500	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1600	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1700	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1800	140	180	72	71	74	140	180	72	71	74	140	180	72	71
1900	140	180	72	71	74	140	180	72	71	74	140	180	72	71
2000	140	180	72	71	74	140	180	72	71	74	140	180	72	71
2100	140	180	72	71	74	140	180	72	71	74	140	180	72	71
2200	140	180	72	71	74	140	180	72	71	74	140	180	72	71
2300	140	180	72	71	74	140	180	72	71	74	140	180	72	71

ENGINE OPERATING HOURS

PREVIOUS TOTAL	30S	MDS	DAYS	SWINGS
147743				
TOTAL TODAY				
TOTAL TO DATE				

3100 down 750

72

DAILY POWER PLANT OPERATING LOG - (TURBINE - BOILER)

ENGINE SERIAL NUMBER: 1106593

ENGINE MFR: GENERATOR MFR: SOLAR ELECTRIC MACHINE CO. MODEL: T-1021S-21

VOLTAGE: 4160 KW: 750

DATE: 1/31/83

TURBINE AND GENERATOR														TURBINE AND GENERATOR														TURBINE AND GENERATOR																						
TIME	KW	KVAR	AMPS	AMPS	VOLTS	T ₁	T ₂	PCD	LOP	LOT	LO	PS	P	TIME	KW	KVAR	AMPS	AMPS	VOLTS	T ₁	T ₂	PCD	LOP	LOT	LO	PS	P	TIME	KW	KVAR	AMPS	AMPS	VOLTS	T ₁	T ₂	PCD	LOP	LOT	LO	PS	P									
MON	1100													MON	1100													MON	1100																					
0100	500	140	73	72	70									0100	500	140	73	72	70								0100	500	140	73	72	70																		
0200	500	140	73	72	70									0200	500	140	73	72	70								0200	500	140	73	72	70																		
0300	500	140	73	72	70									0300	500	140	73	72	70								0300	500	140	73	72	70																		
0400	500	140	73	72	70									0400	500	140	73	72	70								0400	500	140	73	72	70																		
0500	500	140	73	72	70									0500	500	140	73	72	70								0500	500	140	73	72	70																		
0600	500	140	73	72	70									0600	500	140	73	72	70								0600	500	140	73	72	70																		
0700	500	140	73	72	70									0700	500	140	73	72	70								0700	500	140	73	72	70																		
0800	500	140	73	72	70									0800	500	140	73	72	70								0800	500	140	73	72	70																		
0900	500	140	73	72	70									0900	500	140	73	72	70								0900	500	140	73	72	70																		
1000	500	140	73	72	70									1000	500	140	73	72	70								1000	500	140	73	72	70																		
1100	500	140	73	72	70									1100	500	140	73	72	70								1100	500	140	73	72	70																		
1200	500	140	73	72	70									1200	500	140	73	72	70								1200	500	140	73	72	70																		
1300	500	140	73	72	70									1300	500	140	73	72	70								1300	500	140	73	72	70																		
1400	500	140	73	72	70									1400	500	140	73	72	70								1400	500	140	73	72	70																		
1500	500	140	73	72	70									1500	500	140	73	72	70								1500	500	140	73	72	70																		
1600	500	140	73	72	70									1600	500	140	73	72	70								1600	500	140	73	72	70																		
1700	500	140	73	72	70									1700	500	140	73	72	70								1700	500	140	73	72	70																		
1800	500	140	73	72	70									1800	500	140	73	72	70								1800	500	140	73	72	70																		
1900	500	140	73	72	70									1900	500	140	73	72	70								1900	500	140	73	72	70																		
2000	500	140	73	72	70									2000	500	140	73	72	70								2000	500	140	73	72	70																		
2100	500	140	73	72	70									2100	500	140	73	72	70								2100	500	140	73	72	70																		
2200	500	140	73	72	70									2200	500	140	73	72	70								2200	500	140	73	72	70																		
2300	500	140	73	72	70									2300	500	140	73	72	70								2300	500	140	73	72	70																		

ENGINE OPERATING HOURS

PREVIOUS TOTAL: 135907

TOTAL TODAY: 142995

TOTAL TO DATE: 278902

REMARKS: 100% SWINGS

PACKAGE NUMBER: #4

PACKAGE NUMBER: #5

PACKAGE NUMBER: #6

REMARKS: 100% SWINGS

HP	1100	KW	750	DATE	3 Dec 83
VOLTAGE	4160	KW	750		

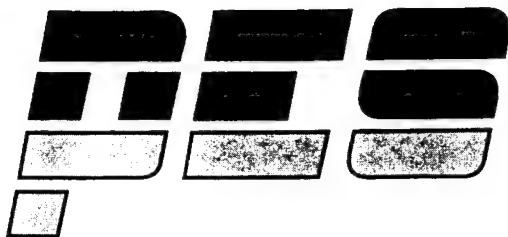
[illegible]

ENGINE OPERATING HOURS						OIL ADDED					
PREVIOUS TOTAL	13027	MIDS				PREVIOUS TOTAL	13835	MIDS			
TOTAL TODAY		DAYS				TOTAL TODAY		DAYS			
TOTAL TO DATE		SWINGS				TOTAL TO DATE		SWINGS			
REMARKS						REMARKS					

ENGINE OPERATING HOURS						OIL ADDED					
PREVIOUS TOTAL	144810	MIDS				PREVIOUS TOTAL	144810	MIDS			
TOTAL TODAY		DAYS				TOTAL TODAY		DAYS			
TOTAL TO DATE		SWINGS				TOTAL TO DATE		SWINGS			
REMARKS						REMARKS					

on line p 850 +

PACKAGE NUMBER	PACKAGE NUMBER	PACKAGE NUMBER
# 7	# 8	# 9



PACIFIC ENVIRONMENTAL SERVICES, INC.

Project No.	F028	Page	1	of	1
Client	ONIZUKA AFB				
Location	POWER PLANT 12/3/93				
Prepared By	Date	Checked By	Date	Sheet Title	
SJD	2/5			POWER GENERATION / KW LOG	

TIME	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12
		↓										
0700	480	570	480	490	460	490	0	0	0	500	440	460
0800	480	570	470	490	460	490	0	0	0	500	440	460
0900	470	570	460	500	510	490	0	490	0	500	410	430
1000	470	570	460	500	510	490	0	500	0	500	460	430
1100	460	570	470	490	510	490	0	490	0	500	460	480
1200	460	570	470	490	510	500	0	490	0	500	470	480
1300	460	570	470	490	510	500	0	490	0	500	480	480
1400	450	570	440	490	510	500	0	490	0	490	510	510
1500	480	565	460	490	500	500	0	500	0	490	490	500
1600	450	540	470	490	500	500	0	500	0	490	490	490
AVG	466	567	465	492	498	498	0	395	0	497	465	472

TOTAL = 4815 KW/HR

GAS
METER

0713 → 1553 = 8.67 HRS

(A) $\frac{998121 \rightarrow 999030}{\times 100} = 909$ UNITS
(B) $302463 \rightarrow 303144 = 681$ UNITS

4815 KWH \times 8.67 HRS = 41746 KWH

41746 KWH / 909 UNITS = 0.0218 UNITS/KWH

41746 KWH / 681 UNITS = 0.0163 UNITS/KWH

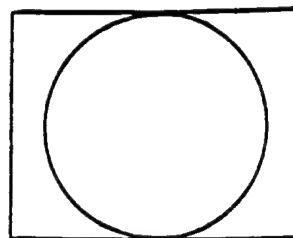
☐ ☐ ☐
☐

MAGY: CA 59

Traverse Point Number	Velocity Head (ΔP_g) in. H ₂ O	Stack Temp. (T _s), °F	Cyclonic Flow Check ° from Null
R1	1.40	444	
2	1.45	450	
3	1.55	449	
4	1.25	444	
		447	
Average	1.18	445	

PRELIMINARY VELOCITY TRAVERSE

Plant: ONIZUKA AFB
 Date: 1-12-94
 Location: TURBINE #2 STACK
 Stack I.D.: 24"
 Barometric Pressure, in. Hg: 30.22
 Stack Gauge Pressure, in. H₂O: 0
 Operators: BROWN
 Pitot Tube I.D. Number: ST4
 Temperature Readout I.D.: FISHER/TC-12
 Pitot Tube Leak Check: OK



Sampling
Location

Schematic of Traverse Point Layout

MAGY = CA59

Traverse Point Number	Velocity Head (Δp_g) in. H ₂ O	Stack Temp. (T_g), °F	Cyclonic Flow Check ° from Null
REF. POINT		L-3	
TEST #1			
10:55	1.65	440	
11:05	1.65	441	
11:15	1.65	442	
11:25	1.65	441	
11:35	1.65	443	
TEST #2			
12:19	1.65	444	
12:29	1.65	442	
12:39	1.65	444	
12:49	1.65	445	
12:59	1.65	444	
Average			

Traverse Point Number	Velocity Head (Δp_g) in. H ₂ O	Stack Temp. (T_g), °F	Cyclonic Flow Check ° from Null
TEST #3			
13:38	1.65	444	
13:48	1.65	445	
13:58	1.65	445	
14:08	1.65	444	
14:18	1.65	445	
Average			

Plant: ONIZUKA AFB

Date: 1-12-94

Source/Sample Number: TURBINE #2 EXHAUST
RUNS 1, 2, 3

$$1. V_m(\text{std}) = (17.64)(V_m)(Y) \left[\frac{P_{\text{bar}} + (\Delta H/13.6)}{T_m} \right]$$

$$V_m(\text{std}) = (17.64)(\quad)(\quad) \left[\frac{(\quad) + (\quad)/13.6}{(\quad)} \right]$$

$$V_m(\text{std}) = \underline{\text{NA}} \text{ dscf.}$$

2. Volume water vapor collected (standard conditions).

$V(l_0) = \underline{\quad}$ condensate from impingers and silica gel.

$$V_w(\text{std}) = (0.04707) V(l_0) = (0.04707)(\quad)$$

$$V_w(\text{std}) = \underline{\text{NA}} \text{ scf.}$$

3. Percent moisture, by volume.

$$Bw_s = \frac{V_w(\text{std})}{V_w(\text{std}) + V_m(\text{std})} = \frac{(\quad)}{(\quad) + (\quad)} = \underline{4.6\%}^*$$

$$Bw_s = \underline{0.046}$$

* FROM PM10 TESTING

4. Molecular weight, stack gas.

Dry molecular weight.

$$M_d = 0.440(\% \text{ CO}_2) + 0.320(\% \text{ O}_2) + 0.280(\% \text{ N}_2 + \% \text{ CO})$$

$$M_d = 0.440(2.5) + 0.320(17.5) + 0.280(80.0)$$

$$M_d = \underline{29.10} \text{ lb/lb-mole.}$$

$$M_s = M_d + Bw_s (18 - M_d) = (29.10) + (0.046)(18 - 29.10)$$

$$M_s = \underline{28.59} \text{ lb/lb-mole.}$$

Plant: ONIZUKA AFB

Date: 1-12-94

Source/Sample Number: TURBINE #2 EXHAUST

RUNS # 1, 2, 3

5. Stack gas velocity average.

$$V_s(\text{avg}) = (85.49)(C_p)(\sqrt{\Delta P}) \left[\text{avg} \sqrt{\frac{(T_s)}{(P_s)(M_s)}} \right]$$

$$V_s(\text{avg}) = (85.49)(1.00)(1.18) \left[\sqrt{\frac{(460+445)}{(30.22)(28.59)}} \right] 905$$

$$V_s(\text{avg}) = \underline{103.2} \text{ ft/sec.}$$

6. Stack volumetric flow rate, actual conditions (stack temperature and pressure).

$$Q_s = (60)(V_s)(A) = (60)(103.2)(3.14)$$

$$Q_s = \underline{19,450} \text{ acfm.}$$

7. Stack volumetric flow rate, standard conditions (68 degrees F, 29.92 Hg).

$$Q(\text{std}) = (17.64)(Q_s)(1 - Bw_s) \left[\frac{(P_s)}{(T_s)} \right]$$

$$Q(\text{std}) = (17.64)(19,450)(1 - 0.046) \left[\frac{(30.22)}{(905)} \right]$$

$$Q(\text{std}) = \underline{10,930} \text{ dscfm.}$$

8. Isokinetic variation.

$$\%I = (K) \left[\frac{(T_s)(V_m(\text{std}))}{(P_s)(V_s)(A_n)(\theta)(1 - Bw_s)} \right]$$

$$\%I = (0.0945) \left[\frac{(\quad)(\quad)(\quad)(\quad)(\quad)}{(\quad)(\quad)(\quad)(\quad)(1 - \quad)} \right]$$

$$\%I = \underline{NA} \%$$

ENGINE MFR	SOLAR	MODEL	T-1021S-21
GENERATOR MFR	ELECTRIC MACHINERY	MODEL	BEMAC II
ENGINE SERIAL NUMBER		20646	

1/12/94

TURBINE AND GENERATOR													BOILER		
TIME	KW	KVAR	AMPS 1	AMPS 2	AMPS 3	VOLTS	T-7	T-6	PCD	LOP	LOT	LO P	INLET AIR TEMP	PSI	P
MDN															
0100															
0200															
0300															
0400															
0500															
0600															
0700															
0800															
0900	550		75	74	75		670	870	73	57	130	5	52	12.5	15
1000	550						680	880	73	57	130	5	56	12.5	15
1100	550						680	880	73	57	130	5	60	12.5	15
1200															
1300	550						700	900	72	57	130	5	64	12.5	15
1400	550						700	900	72	57	130	5	66	12.5	15
1500	540						710	905	72	58	130	5	68	12.5	15
1600	540						710	905	72	58	130	5	68	12.5	15
1700															
1800							Secured (C)							1745	
1900															
2000															
2100															
2200															
2300															

ENGINE OPERATING HOURS		OIL ADDED	
PREVIOUS TOTAL	152497	MDS	
TOTAL TODAY	10	DAYS	
TOTAL TO DATE	152507	SWINGS	

REMARKS

PACKAGE NUMBER

2

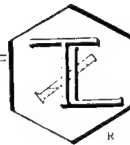


APPENDIX C
LABORATORY REPORTS AND ANALYTICAL METHODS

REPORT

TRUESDAIL LABORATORIES, INC.

CHEMISTS - MICROBIOLOGISTS - ENGINEERS
RESEARCH - DEVELOPMENT - TESTING



14201 FRANKLIN AVENUE
TUSTIN, CALIF. 92680
AREA CODE 714 • 730-6239
AREA CODE 213 • 225-1564
FAX 714 • 730-6462

CLIENT **PACIFIC ENVIRONMENTAL SERVICES, INC.**
13100 Brooks Drive
Baldwin Park, CA 91706
Attn: S. Hugh Brown

DATE Jan. 18, 1994
RECEIVED Jan. 14, 1994
LABORATORY NO. 53691

SAMPLE 3 tanks from project PES/ONIZUKA AFB

INVESTIGATION

Total hydrocarbon analysis by SCAQMD method 25.2

RESULTS

The submitted samples were analyzed for CH₄, CO, CO₂ and nonmethane hydrocarbons (as C₁) by SCAQMD Method 25.2. Oxygen concentrations were determined by Orsat analysis.

The results obtained are as follows:

PACIFIC ENVIRONMENTAL SERVICES, INC.

LN 53691

<u>SAMPLE</u>	<u>ID</u>	<u>NMVHC</u> <u>ppmvC₁</u>	<u>CH₄</u> <u>ppmv</u>	<u>CO</u> <u>ppmv</u>	<u>CO₂</u> <u>ppmv</u>	<u>O₂</u> <u>%V</u>
Test-1	108	ND	7	60	18610	17.9
Test-2	117	11	6	58	18590	18.2
Test-3	106	ND	6	57	18700	18.1
Detection limit		4	2	2	2	0.2

ND = Not detect

TRUESDAIL LABORATORIES, INC.

Prepared by:

Xuan Huong Dang

Xuan Huong Dang
Analytical Chemist
Air Pollution Testing

Reviewed by:

Charles M. Figueroa

Charles M. Figueroa
Project Manager
Air Pollution Testing



TCA-SOP
Revision: Draft
Date: 11/91
Prepared By:
Page 1 of 10

**DETERMINATION OF HYDROCARBON EMISSIONS BY
TOTAL COMBUSTION ANALYSIS (TCA) METHOD**

Table of Contents

1.0	Applicability
2.0	Equipment List
3.0	Preparation of sampling train
4.0	Sampling at test site
5.0	Analytical procedure
6.0	Gaseous sample analysis
7.0	Condensate trap recovery
8.0	Calculations
9.0	Diagrams

Method

This method is based on SCAQMD METHOD 25.1

1.0 Summary of Method

This procedure uses a sampling train comprising a stainless steel probe and a freeze-out trap connected to an evacuated seven-liter tank via a Magnehelic pressure differential gauge. The trap is used for collecting the condensable organic matter while the non-condensable gases are being collected in the tank.

2.0 Equipment list

- 2.1 7-liter tank with vacuum gauge
- 2.2 Stainless steel condensate trap and probe
- 2.3 Magnehelic gauge
- 2.4 Metal Dewar flask with dry ice
- 2.5 Tank holder

3.0 Preparation of sampling train

- 3.1 Determine the number of tanks and traps required, and match only outlet tanks with outlet traps for sampling at an outlet location. Similarly, the principle applies to inlets.
- 3.2 Using a high-volume vacuum pump, evacuate the 7-liter tanks to a pressure of 1 Torr or less three times, filling the tanks to one atmosphere between evacuations.
- 3.3 After the third evacuation, turn off the valves and check for leaks by allowing the tanks to stand for at least 16 hours, after which period any leaks will become apparent by a change in the vacuum gauge readings.
- 3.4 For convenience in transporting as well as ease of handling at the test site, two tanks can be placed in a wooden holder.

3.5 Set up each train in the following sequence: tank, Magnehelic gauge, trap, and probe. Be sure to determine the proper torque required to tighten these crucial connections, as too much torque will spoil the fittings for future connections while too little torque will result in leakage.

3.6 Perform a leak check on each train by introducing nitrogen into the connections at the probe tip. Magnehelic needle will deflect and should return to the same "zero" point after a short while. This signifies a good leak check.

3.7 The assembly is now ready for transport to the test site. It should be noted that triplicate samples are usually taken at the inlet locations and duplicates for outlets.

4.0 Sampling at test site

4.1 Conduct pre-test flow and temperature measurements according to method described in Truesdail Laboratories, Inc. S.O.P. Before the stack traverse, make sure that both the air pollution control unit and the production line is running at the conditions in the test protocol or on the AQMD's "Permit to Construct."

4.2 Immerse the traps into the metal Dewar flask filled with crushed dry ice to a depth of four inches. Maintain the dry ice level for the whole duration of the test.

4.3 Uncap the probe tips and wrap the tips as close as possible to each other in order to satisfy duplicate or triplicate sampling. Avoid touching the tips to prevent contamination.

4.4 Insert the probes into the sampling port carefully so as not to scrape the port walls on the way in. Position the tips near the center of the duct. The port should then be sealed off with duct tape.

4.5 Coordinate all sampling stations, i.e., begin and end the test simultaneously. Integration times will vary from 30 to 120 minutes.

4.6 During the sampling period, record the vacuum gauge reading at 5-minute intervals and make field notes regarding any unusual events which may affect subsequent analytical results. Examples being: (1) the plugging of flow due to a frozen line, and (2) problems associated with the production line.

4.7 Adjust the flow into the tanks such that between 5 to 10 inches of vacuum remain at the end of the sampling period. Close all valves at the end of the test.

4.8 Remove the probes from the duct carefully and cap off the probe tips.

4.9 Perform a post-test leak check by opening the valves. The Magnehelic needle will deflect and will settle down to its original position if there are no leaks. Make a note otherwise.

4.10 Label all tanks and traps accordingly, i.e., include the name of client, sampling date and location, and test and tank number.

4.11 For verification and quality control purposes, conduct a post-test flow and temperature measurement.

4.12 Transport the assemblies to the laboratory for analysis.

4.13 Disconnect the sampling trains and plug the open end of the traps. Store the traps in a dry ice or household freezer until they can be processed.

4.14 Measure the pressure in the tanks with a manometer and add pre-purified dry nitrogen to an absolute pressure of at least 860 Torr.

4.15 Record these pressures as they will be needed for further analytical computations. The corrected barometric pressure and temperature are to be recorded as well.

5.0 Analytical description

This involves the separate determinations of carbon monoxide, methane and carbon dioxide, and the combined determination of C_2 and higher molecular weight hydrocarbons. Results are reported as parts per million (ppm) and pounds per hour (lb/hr) as carbon.

The gaseous portion and condensables portion are analyzed separately. The analysis of the gaseous portion requires a gas chromatographic column to separate and elute, in order, carbon monoxide, methane and carbon dioxide in the sample. The separated components are then methanized and detected by a flame ionization detector (FID). The amount of methane measured by the FID is recorded on a chromatogram strip chart.

The analysis of the volatile hydrocarbons in the gaseous portion requires a gas chromatographic column preceded by a 7-inch loop of Tenax material placed in an ice bath ($0^{\circ}C$) which absorbs the C_3 and higher hydrocarbons. The C_2 hydrocarbons are separated from carbon monoxide, methane and carbon dioxide in the sample (which elute together) by the chromatographic column. After C_2 is eluted, the carrier gas flow direction is reversed and the Tenax loop is heated with boiling water ($100^{\circ}C$) to desorb the remaining hydrocarbons. As each component is eluted, it passes through a catalytic oxidizer which converts it to carbon dioxide. Each carbon dioxide peak is measured by a non-dispersive infrared (NDIR) spectrophotometer, utilizing a carbon dioxide detector, and quantified by a computing integrator (GC/NDIR).

The condensable portion of the sample is analyzed for total hydrocarbons as carbon by volatilizing the trap contents and catalytically oxidizing everything to carbon dioxide which is then collected in an evacuated vessel and quantitatively determined by the FID as mentioned in 5.2.

In order to obtain meaningful analytical data, it is necessary to procure accurate reference standards and to calibrate the instruments with these standards at frequent intervals. Known concentrations of carbon monoxide, methane, carbon dioxide and propane in dry nitrogen are purchased from a vendor and are NBS traceable ($\pm 2\%$).

6.0 Gaseous sample analysis

6.1 Record the room temperature and barometric pressure.

6.2 After the sample tanks have settled down to room temperature, the absolute pressure is measured with a mercury manometer. The tanks are then pressurized with dry nitrogen to at least 32 inches of mercury (absolute), re-equilibrated, and measured again. The measurements are recorded and a dilution factor calculated.

6.3 The GC/FID instrument is calibrated with a standard gas sample.

6.4 The pressurized sample is used to flush the sample loop on the gas chromatograph with sample and the injection valve actuated to place the loop into the carrier circuit.

6.5 The sample fractions are eluted in order - methane, carbon monoxide, and carbon dioxide - and plotted on a strip chart chromatogram.

6.6 A computer instantaneously integrates and calculates each sample peak with the appropriate constants and correction factors, and reports these values at the end of the chromatogram. Replicate runs are made until $\pm 5\%$ maximum deviation is obtained.

6.7 The GC/NDIR instrument is standardized with a standard gas sample.

6.8 The pressurized sample is used to flush the sample loop on the gas chromatograph with sample.

6.9 The injection valve is actuated, placing the sample loop into the carrier circuit with the Tenax loop immersed in an ice bath.

6.10 When the C_2 hydrocarbons have been eluted or their retention time passed, the carrier gas flow through the Tenax and GC column is reversed and the Tenax loop immersed in boiling water. The C_3 and higher molecular weight hydrocarbons are eluted together and plotted with the previous peaks on a strip chart chromatogram after detection by the NDIR analyzer.

6.11 A computer instantaneously integrates and calculates each sample peak with the appropriate constants and correction factors and reports these values at the end of the chromatogram. Replicate runs are made until $\pm 5\%$ maximum deviation is achieved.

6.12 In the event that any of the hydrocarbon peaks are high enough to make the analyzer off scale, the sample is re-analyzed using a smaller loop and an appropriate standard.

7.0 Condensate trap recovery

7.1 Place the trap in a dry ice cooling bath and then heat the ends of the trap with a Bunsen burner to drive the hydrocarbons into the cold section of the trap away from the plugs.

7.2 After a minimum of five minutes in the cooling bath, the plugs are removed from the trap and the trap is then connected to the carrier gas on one end and a 1.8-liter evacuated vessel on the other end. The trap is purged at a rate similar to the sampling rate until at least 1 liter of purged gases are collected for at least six minutes.

7.3 Remove the purge gas vessel. Another evacuated collection vessel is attached to the NDIR effluent and flow re-established in a push-pull fashion. The trap is connected to the oxidizer, followed by a sulfuric acid bubbler to remove moisture and a NDIR carbon dioxide analyzer to indicate how much hydrocarbon is left in the trap.

7.4 The cooling bath is removed and the trap is slowly heated with a Bunsen burner until the stainless steel trap reaches a dull red glow and the sample is eluted from the trap as indicated by the NDIR.

7.5 The collection vessel is analyzed for carbon dioxide by GC/FID as in 6.1 thru 6.6.

7.6 The purge gas vessel is analyzed for volatile hydrocarbons by GC/NDIR as in 6.7 thru 6.12.

7.7 For traps where low condensables are expected, especially outlet ones, with the possibility of high moisture and carbon dioxide in the samples, the trap is placed in a water bath at room temperature and connected to a short loop of stainless steel (1/4-inch O.D.) packed with quartz wool and placed in a dry ice bath. The purge step is then performed and the purge loop incorporated into the trap analysis as in 7.3. This alternative procedure will minimize the amount of unpurged stack carbon dioxide which may have dissolved in the trap condensate.

8.0 Calculations

8.1 Condensable hydrocarbons:

- (a) Integrate the area of the standard.
- (b) Integrate the area of the sample.
- (c) Calculate the concentration in ppm of carbon equivalent as follows:

$$C_{\text{smpl}} = \frac{C_{\text{std}} \times A_{\text{smpl}} \times V_{\text{ves}} \times \frac{P_{\text{tank}}}{29.9} \times \frac{520}{460+T}}{A_{\text{std}} \times V_{\text{tank}} \times \frac{P_{\text{tank}}}{29.9} \times \frac{520}{460+T}}$$

where C_{smpl} = concentration of the sample in ppm,
 C_{std} = concentration of the standard in ppm,
 A_{smpl} = area of the sample,
 A_{std} = area of the standard,
 V_{tank} = volume of the sample tank in liter,
 V_{ves} = volume of the collection vessel in liter,
 P_{tank} = pressure (absolute) of the tank in inches of mercury, and
 T = room temperature in °F.

8.2 Volatile hydrocarbons and gaseous components:

- (a) Integrate the area of the standard.
- (b) Integrate the area of the standard components.
- (c) Calculate the concentration in ppm of carbon equivalent as follows:

$$C_{smp1} = \frac{C_{std} \times A_{smp1} \times \frac{P_B + P_f}{P_B + P_i}}{A_{std}}$$

where P_B = barometric pressure (net) in inches of mercury,
 P_i = residual pressure of sample tank, and
 P_f = final pressure of sample tank after N_2 addition.

8.3 The following formula is used for the computation of the emission rate in lb/hr carbon:

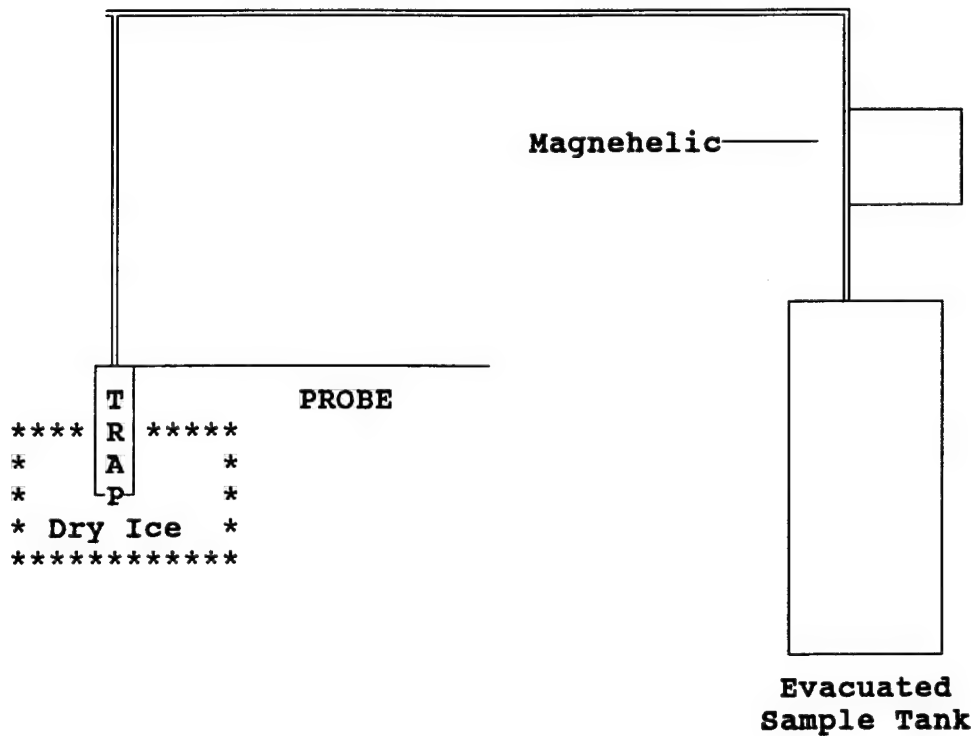
$$\frac{C \times 12 \text{ lb/mole} \times Q_{sd}}{3.79 \times 10^8 \text{ ft}^3/\text{lb.mole}}$$

where C = total concentration of hydrocarbons present in ppm, and
 Q_{sd} = flow rate in standard ft^3/hr (dry).

9.0 Diagrams

Diagrams of the assembly is shown on the following page. Note that the distance between the dry ice top surface and the sampling probe of the trap should be at least one inch so that water will not freeze in the narrow sampling tube.

TCA Sampling Train Setup



Revision: Draft
Date: 11/91
Prepared by: XHD
Approved by: PDM
QA Approval: TJP
Page: 1 of 8

**STANDARD OPERATING PROCEDURE FOR:
TOTAL HYDROCARBON ANALYSIS BY SCAQMD 25.1**

Table of Contents

1.0	Method
2.0	Principle
3.0	Applicability
4.0	Apparatus
5.0	Reagents
6.0	Procedure
7.0	Calculations

**STANDARD OPERATING PROCEDURE FOR:
TOTAL HYDROCARBON ANALYSIS BY SCAQMD 25.1**

Method

This method is based on SCAQMD METHOD 25.1. It is intended for the determination of total hydrocarbons in source emissions.

1.0 Principle

Samples are collected in two fractions by using an evacuated tank to draw gases through a condensate trap chilled in dry ice. In this modification of the method, both fractions are separately analyzed for carbon monoxide, methane and carbon dioxide, in addition to a combined determination of C2 and higher molecular weight hydrocarbons. Results are reported as parts per million (PPM) in the sample, and as pounds of carbon per hour from the source.

Applicability

This method is applicable to determination of stationary source emissions including incinerators, boilers and absorbers.

2.0 Equipment Required

- 2.1 GC/FID
- 2.2 GC/NDIR
- 2.3 Ice water bath: 1000ml Beaker filled with ice and deionized water.
- 2.4 Boiling water bath: 1000 ml Beaker filled with deionized water, wire gauze, tripod and Bunsen burner.
- 2.5 Dry ice.
- 2.6 Evacuated 1.8 liter vessel.
- 2.7 Condensate trap

3.0 Reagents Required

See 3.1 and 3.2 of SOP titled TCA 25.2/SOP

4.0 Procedure

This method requires the use of two different instruments, GC/FID and GC/NDIR and Orsat equipment. The samples are collected in two fractions, a gaseous fraction and a condensible fraction. Each fraction must be analyzed separately using both instruments.

4.1 Preparation of Gaseous Fraction of Sample

- 4.1.1 Record room temperature and barometric pressure.
- 4.1.2 When the sample has equilibrated to room temperature, measure the absolute pressure in the sample cylinder with a mercury manometer, and record the result as residual vacuum (R.V.).
- 4.1.3 Pressurize the sample cylinder with ultra-pure nitrogen to at least 6 inches of mercury (absolute), then allow to equilibrate to room temperature (about 5 minutes).
- 4.1.4 Repeat the measurement of absolute pressure, and record the result as pressure of nitrogen (PN₂).
- 4.1.5 Calculation for dilution factor (XF) and sample amount (SA) (see 5.1).

4.2 Preparation of Condensable Fraction of Sample

Note: Inlet traps and outlet traps differ substantially in the level of hydrocarbons present, and so require slightly different handling. Several of the steps below will contain alternative instructions for onlet and outlet traps. Inlet traps and outlet traps are kept separate; inlet traps are not used to sample outlets, and vice versa in order to avoid sample carry-over problems.

- 4.2.1 Evacuate two 2 liter tanks to -30" Hg. Prepare a solution of 0.1N H₂SO₂ for the knock-out which is connected between the catalyst and the NDIR. The water knock-out also requires an ice bath.
- 4.2.2 Determine the baseline for the NDIR. On range 3, the baseline will usually be between 10 and 15 at room temperature.

TRUESDAIL LABORATORIES, INC.

- 4.2.3 Remove the trap from the freezer. Inlet traps: immerse the trap in a dry ice bath, connect one side of the trap to the carrier gas, and the other to an evacuated tank. Outlet traps: connect one side of the trap to the carrier gas, and the other side to a cold finger which is immersed in a dry ice bath (the trap itself is allowed to warm to room temperature). The other side of the cold finger is connected to an evacuated tank.
- 4.2.4 Start the carrier gas flowing through the trap for 5 minutes, until the pressure in the tank is about -10" Hg. This tank is then analyzed and added to the sample collected in the trap.
- 4.2.5 Connect the trap to the catalyst column. Attach a second evacuated cylinder to the outlet of the NDIR. If an inlet is being burned, use an eight liter cylinder. If an outlet is being burned, use a two liter flask. Perform a leak check by turning on the carrier gas flow briefly. Watch the bubbles in the water knock-out. When the bubbles stop with the system pressurized and the carrier gas is turned off, there should be a complete equilibrium in the drop-out. The presence of water moving backwards in the drop-out signifies a leak in the trap or catalyst. If bubbles continue to flow, there is a leak in the NDIR or tank connection.
- 4.2.6 Start the carrier gas flow, remove the dry ice bath and begin heating the trap with the burners. For inlet traps, set the supplemental oxygen flow to match the carrier gas flow. For outlet traps, burn the cold finger along with the trap: supplemental oxygen is not needed in most cases. Observe the reading on the NDIR. It should quickly begin to rise.
- 4.2.7 Continue burning the trap until the NDIR reading falls to near the blank value. The trap is allowed to cool to room temperature, and then is briefly heated again to determine whether all the condensable hydrocarbons have been driven off. If the NDIR reading does not increase during this final check the trap is clean. It is important that hydrocarbons will condense in the tubing and

that it must be burned out with the trap. Also any place there is a connector, it must be heated to make sure that the inside is cleaned.

- 4.2.8 The tank from the burn and the purge are pressurized and analyzed (see above for gas sample portion).

4.3 GC/FID Analysis of Samples

- 4.3.1 Check carrier gas (UP He), if low, change the gas tank.
- 4.3.2 Change the output from "test" to "1", change the range from "Bal" to "10".
- 4.3.3 Increase He to 50 psi.
- 4.3.4 Turn on H₂ to 30 psi.
- 4.3.5 Ignite the FID.
- 4.3.6 Turn on Air to 20 psi.
- 4.3.7 Increase He to 80 psi.
- 4.3.8 Turn FID Zero Suppression on, and switch detector Output from "1" to "2".
- 4.3.9 Let the instrument warm up for 20 minutes.
- 4.3.10 Start the Maxima program of the Dynamic Solutions system, and set up the automatic data acquisition according to the manual Maxima 820.
- 4.3.11 Standard Calibration - Calibration standards are commercial stock standard mixtures made from certified gas company.
 - (a) Inject a standard sample through a sample loop on the GC.
 - (b) Press "Run" on the GC to place the loop into the carrier gas circuit.
 - (c) The calibration standards are run in replicate until +/- 2% maximum deviation is obtained.
- 4.3.12 The sample is injected in the same manner as the standard, steps 4.3.11: a, b, and c.

TRUESDAIL LABORATORIES, INC.

4.4 GC/NDIR Analysis of Samples

- 4.4.1 Turn on the instrument and allow the GC oven to reach analysis temperature (approximately about 800 F).
- 4.4.2 Start Nitrogen flow.
- 4.4.3 Turn on the integrator: change the RANGE from "Tune" to "1", set GAIN from "0" to "5".
- 4.4.4 When the GC oven reaches 800 F, turn the ZERO tune all the way to the right, and then adjust the SOURCE BALANCE until it reads between 35-40.
- 4.4.5 Adjust the ZERO tune until the display reads "2" by turning it to the left.
- 4.4.6 Equilibrate the Tenax loop in the ice water bath.
- 4.4.7 Run a blank sample to check for carry-over prior to running standard.
- 4.4.8 Standard Calibration - Calibration standards are commercial stock standard from certified gas company.
 - (a) Flush the sample loop with the pressurized standard, then switch the injection valve to inject the sample.
 - (b) Press "Start" on the integrator.
 - (c) When the C_2 has been eluted or their expected retention time has passed, the carrier gas flow direction is reversed, and the Tenax loop is immersed in boiling water to desorb the remaining hydrocarbons.
 - (d) The calibration standards are repeated until +/- 5% maximum deviation is obtained.
- 4.4.9 Inject the sample in the same manner as the standard, steps 4.4.8: a, b, and c
- 4.4.10 Repeat the analysis of samples until +/-5% maximum deviation is obtained. If any of the hydrocarbons peaks are off scale, recalibrate the GC using a new standard that is closer to the concentration of the sample and then reanalyze the sample.

TRUESDAIL LABORATORIES, INC.

4.5 Dilution

See 4.5 of the SOP titled TCA 25.2

4.6 Orsat analysis of samples

See SOP titled 7.1

5.0 Calculations

5.1 Condensable Hydrocarbons

5.1.1 The integrated area for the standard and the sample are available directly from the chart recorder.

5.1.2 Calculate the concentration in ppm of carbon equivalent as follows:

$$C_{\text{smpl}} = \frac{C_{\text{std}} \times A_{\text{smpl}} \times V_{\text{ves}} \times \frac{P_{\text{tank}}}{29.9} \times \frac{520}{460+T}}{A_{\text{std}} \times V_{\text{tank}} \times \frac{P_{\text{tank}}}{29.9} \times \frac{520}{460+T}}$$

where

C_{smpl} = concentration of the sample in ppm,
 C_{std} = concentration of the standard in ppm,
 A_{smpl} = area of the sample,
 A_{std} = area of the standard,
 V_{tank} = volume of the sample tank in liter,
 V_{ves} = volume of the collection vessel in liter,
 P_{tank} = pressure (absolute) of the tank in inches of mercury,
 T = room temperature in F.

5.2 Volatile hydrocarbons and gaseous components

5.2.1 The integrated area for the standard and the sample are available directly from the chart recorder.

5.2.2 Calculate the concentration in ppm of carbon equivalent as follows:

TRUESDAIL LABORATORIES, INC.

$$C_{smp1} = \frac{C_{std} \times A_{smp1} \times \frac{(P_B + P_f)}{(P_B + P_i)}}{A_{std}}$$

where:

P_B = barometric pressure (net) in inches of mercury,
 P_i = residual pressure of sample tank,
 P_f = final pressure of sample tank after N₂ addition.

The following formula is used for the computation of the emission rate in lb/hr carbon:

$$\frac{C \times 12 \text{ lb/mole} \times Q_{sd}}{3.79 \times 10^8 \text{ ft}^3/\text{lb.mole}}$$

where:

C = total concentration of hydrocarbons present in ppm,
 Q_{sd} = flow rate in standard cubic feet per hour (dry).



APPENDIX D
CALIBRATION DATA



Scott Specialty Gases, Inc.

2600 CAJON BOULEVARD, SAN BERNARDINO, CA 92411

(909) 887-2571 FAX (909) 887-0549

CERTIFICATE OF ANALYSIS: EPA PROTOCOL GAS RECERTIFICATION

Customer
PACIFIC ENVIRONMENT SER
ATTN: STEVE HERNANDEZ
13100 BROOKS DRIVE
BALDWIN PARK CA91706

Assay Laboratory
Scott Specialty Gases
2600 Cajon Boulevard
San Bernardino, CA 92411

Purchase Order 0640-102
Scott Project # 25837.001

ANALYTICAL INFORMATION

Certified to exceed the minimum specifications of EPA Protocol 1 Procedure #G1, Section Number 3.0.4

Cylinder Number ALM027046
Cylinder Pressure 2000PSIG

Certification Date 12-23-93
Previous Certification Dates 05-20-93

Acid Rain Exp.
General Exp. 12-23-95

ANALYZED CYLINDER

Components
NITRIC OXIDE

Certified Concentration
43.83PPM

Analytical Uncertainty*
±1% NIST Traceable

Balance Gas: Nitrogen
NOX

44.17PPM

*Analytical uncertainty is inclusive of usual known error sources which at least includes reference standard error & precision of the measurement processes.

REFERENCE STANDARD

Type GMIS
Expiration Date 09-94

Cylinder Number
ALM033883

Concentration
100.4PPM

INSTRUMENTATION

Instrument/Model/Serial #
TECO / 10AR-38644-258

Last Date Calibrated
10-29-93

Analytical Principle
Chemi-Luminescent

ANALYZER READINGS (Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

Components
NITRIC OXIDE

Previous Certification

Date: 05-20-93 **Response Units:** mv
Z1= R1= T1=
R2= Z2= T2=
Z3= T3= R3=
Avg. Conc. of Cust Cyl. 43.83PPM

Third Triad Analysis

Date: 12-23-93 **Response Units:** mv
Z1= 0.00 R1= 97.0 T1= 41.8
R2= 97.0 Z2= 0.00 T2= 41.8
Z3= 0.00 T3= 41.8 R3= 97.0
Avg. Conc. of Cust Cyl. 43.83PPM

Calibration Curve

Concentration= Ax + B
A = 1.0083945
B = -0.139473

Date: **Response Units:**
Z1= R1= T1=
R2= Z2= T2=
Z3= T3= R3=
Avg. Conc. of Cust Cyl.

Date: **Response Units:**
Z1= R1= T1=
R2= Z2= T2=
Z3= T3= R3=
Avg. Conc. of Cust Cyl.

Concentration=

Date: **Response Units:**
Z1= R1= T1=
R2= Z2= T2=
Z3= T3= R3=
Avg. Conc. of Cust Cyl.

Date: **Response Units:**
Z1= R1= T1=
R2= Z2= T2=
Z3= T3= R3=
Avg. Conc. of Cust Cyl.

Concentration=

SPECIAL NOTES: IF THIS PRODUCT IS USED FOR ACID RAIN COMPLIANCE, THE ACID RAIN DATE NOTED ABOVE APPLIES PER 40 CFT PART 75, APPENDIX H. OTHERWISE THE GENERAL EXPIRATION DATE APPLIES.

Analyst



Scott Specialty Gases, Inc.

2600 CAJON BOULEVARD, SAN BERNARDINO, CA 92411

(909) 887-2571 FAX: (909) 887-0549

CERTIFICATE OF ANALYSIS: EPA PROTOCOL GAS

Customer:
Pacific Environmental Services
13100 Brooks Drive
Baldwin Park, CA 91706-0740

Assay Laboratory
Scott Specialty Gases
2600 Cajon Boulevard
San Bernardino, CA 92411

Purchase Order 0640-102
Scott Project # 24700

ANALYTICAL INFORMATION

Certified to exceed the minimum specifications of EPA Protocol 1 Procedure #G1, Section Number 3.0.4

Cylinder Number ALM027851
Cylinder Pressure 1950 psig

Certification Date 03-17-93
Previous Certification Dates NONE

Expiration Date 09-13-94

ANALYZED CYLINDER

Components
Nitric Oxide

Certified Concentration
22.51 ppm

Analytical Uncertainty*
± 1 % NIST Traceable

NOX
Balance Gas: Nitrogen

22.82 ppm

*Analytical uncertainty is inclusive of usual known error sources which at least includes reference standard error & precision of the measurement processes.

REFERENCE STANDARD

Type SRM 2629A
Expiration Date 09-93

Cylinder Number
FF28519

Concentration
19.3 ppm

INSTRUMENTATION

Instrument/Model/Serial #
TECO / 10AR / 14853-150

Last Date Calibrated
1-20-93

Analytical Principle
Chemi-Luminescent

ANALYZER READINGS (Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

Components

Nitric Oxide

First Triad Analysis

Date: 03-01-93 **Response Units:** mv
Z1= 0.000 R1= 78.33 T1= 90.95
R2= 78.30 Z2= 0.000 T2= 90.92
Z3= 0.000 T3= 90.94 R3= 78.28
Avg. Conc. of Cust Cyl. 22.41 ppm

Second Triad Analysis

Date: 03-17-93 **Response Units:** mv
Z1= 0.000 R1= 77.12 T1= 90.20
R2= 77.24 Z2= 0.000 T2= 90.54
Z3= 0.000 T3= 90.50 R3= 77.21
Avg. Conc. of Cust Cyl. 22.60 ppm

Calibration Curve

Concentration= Ax^2+Bx+C
A = -0.000504296
B = 1.0489880
C = -0.292506

Date: **Response Units:** mv
Z1= R1= T1=
R2= Z2= T2=
Z3= T3= R3=
Avg. Conc. of Cust Cyl.

Date: **Response Units:** mv
Z1= R1= T1=
R2= Z2= T2=
Z3= T3= R3=
Avg. Conc. of Cust Cyl.

Concentration=

Date: **Response Units:**
Z1= R1= T1=
R2= Z2= T2=
Z3= T3= R3=
Avg. Conc. of Cust Cyl.

Date: **Response Units:**
Z1= R1= T1=
R2= Z2= T2=
Z3= T3= R3=
Avg. Conc. of Cust Cyl.

Concentration=

Special Notes

Joseph De La Torre
Analyst Joseph De La Torre



Scott Specialty Gases, Inc.

2600 CAJON BOULEVARD, SAN BERNARDINO, CA 92411

(909) 887-2571 FAX: (909) 887-0549

CERTIFICATE OF ANALYSIS: EPA PROTOCOL GAS

Customer
PACIFIC ENVIRONMENTAL SER.
PO# 0640-102
13100 BROOKS AVE
BALDWIN PARK, CA 91706

Assay Laboratory
Scott Specialty Gases
2600 Cajon Boulevard
San Bernardino, CA 92411

Purchase Order 0640-102
Project # 27964.001

ANALYTICAL INFORMATION

Certified to exceed the minimum specifications of EPA Protocol 1 Procedure #G1, Section Number 3.0.4

Cylinder Number ALM034155
Cylinder Pressure 1900 psig

Certification Date 10-06-93

GENERAL Date 10-06-95

ACID RAIN DATE

ANALYZED CYLINDER

Components
NITRIC OXIDE

Certified Concentration
22.90 PPM

Analytical Uncertainty*
± 1 % NIST Traceable

Balance Gas: Nitrogen
NOX

23.46 PPM

*Analytical uncertainty is inclusive of usual known error sources which at least includes reference standard error & precision of the measurement processes

REFERENCE STANDARD

Type GMS
Expiration Date 01-94

Cylinder Number
ALM033911

Concentration
24.97 ppm

INSTRUMENTATION

Instrument/Model/Serial #
TECO / 10AR / 38644-258

Last Date Calibrated
07-26-93

Analytical Principle
Chemi-Luminescent

ANALYZER READINGS (Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

Components

First Triad Analysis

Second Triad Analysis

Calibration Curve

Nitric Oxide

Date: 09-29-93 Response Units: mv
Z1= 0.00 R1= 96.4 T1= 88.5
R2= 96.4 Z2= 0.00 T2= 88.5
Z3= 0.00 T3= 88.5 R3= 96.4
Avg. Conc. of Cust Cyl. 22.91 ppm

Date: 10-06-93 Response Units: mv
Z1= 0.00 R1= 96.4 T1= 88.4
R2= 96.4 Z2= 0.00 T2= 88.3
Z3= 0.00 T3= 88.3 R3= 96.4
Avg. Conc. of Cust Cyl. 22.88 ppm

Concentration= Ax + B
A=1.001
B=0.05283

Date: Response Units: mv
Z1= R1= T1=
R2= Z2= T2=
Z3= T3= R3=
Avg. Conc. of Cust Cyl.

Date: Response Units: mv
Z1= R1= T1=
R2= Z2= T2=
Z3= T3= R3=
Avg. Conc. of Cust Cyl.

Concentration=

Date: Response Units: mv
Z1= R1= T1=
R2= Z2= T2=
Z3= T3= R3=
Avg. Conc. of Cust Cyl.

Date: Response Units: mv
Z1= R1= T1=
R2= Z2= T2=
Z3= T3= R3=
Avg. Conc. of Cust Cyl.

Concentration=

SPECIAL NOTES: IF THIS PRODUCT IS USED FOR ACID RAIN COMPLIANCE,
THE ACID RAIN EXPIRATION DATE NOTED ABOVE APPLIES PER 40 CFT PART
75, APPENDIX H. OTHERWISE THE GENERAL EXPIRATION DATE APPLIES.

ANALYST

Thomas E. Wilson



Scott Specialty Gases, Inc.

Shipped From: 2600 CAJON BLVD.
SAN BERNARDINO CA 92411
Phone: 909-887-2571 Fax: 909-887-0549

CERTIFICATE OF ANALYSIS

PACIFIC ENVIRONMENTAL SER
PO# 0640-102
13100 BROOKS DRIVE

BALDWIN PARK

CA 91706

PROJECT #: 02-28622-001
PO#: 0640-102
ITEM #: 02024520 4AL
DATE: 11/11/93

CYLINDER #: ALM035757
FILL PRESSURE: 2000PSIG
BLEND TYPE : CERTIFIED MASTER GAS

ANALYTICAL ACCURACY: +/-1%NIST

COMPONENT	REQUESTED GAS		ANALYSIS	
	CONC	MOLES	(MOLES)	
CARBON DIOXIDE	11.	PCT	11.09	PCT
CARBON MONOXIDE	50.	PPM	50.11	PPM
OXYGEN	11.	PCT	11.00	PCT
NITROGEN		BAL		BAL

2000PSIG BIN#2 11-12-93
CRM1675 14.08%CO2 ALM001136
CRM1678 47.2PPM AAL5970 CO
CRM2659 20.63% ALM017555 O2

ANALYST: 

PLUMSTEADVILLE, PENNSYLVANIA / TROY, MICHIGAN / HOUSTON, TEXAS / DURHAM, NORTH CAROLINA
SOUTH PLAINFIELD, NEW JERSEY / FREMONT, CALIFORNIA / WAKEFIELD, MASSACHUSETTS / LONGMONT, COLORADO
BATON ROUGE, LOUISIANA



Scott Specialty Gases, Inc.

Shipped
From:

2600 CAJON BLVD.
SAN BERNARDINO CA 92411
Phone: 909-887-2571

Fax: 909-887-0549

C E R T I F I C A T E O F A N A L Y S I S

PACIFIC ENVIRONMENTAL SER
STEVE HERNANDEZ
13100 BROOKS DRIVE

BALDWIN PARK

CA 91706

PROJECT #: 02-27898-001
PO#: 0640-102
ITEM #: 02024520 2AL
DATE: 10/01/93

CYLINDER #: ALM036879
FILL PRESSURE: 2000 PSIG
BLEND TYPE : ACUBLEND MASTER GAS

ANALYTICAL ACCURACY: +-1%

COMPONENT

CARBON DIOXIDE
CARBON MONOXIDE
OXYGEN
NITROGEN

REQUESTED GAS

CONC MOLES

18. PCT
75. PPM
19. PCT
BAL

ANALYSIS

(MOLES)

18.00 PCT
75.00 PPM
19.00 PCT
BAL

2000 PSIG BIN#2 10-08-93
CRM1679 ALM10524 CO

CRM1675 ALM001136 CO2,
CRM2659 ALM017555 O2

ANALYST: _____



Scott Specialty Gases, Inc.

Shipped 2600 CAJON BLVD.
 From: SAN BERNARDINO CA 92411
 Phone: 909-887-2571 Fax: 909-887-0549

C E R T I F I C A T E O F A N A L Y S I S

PACIFIC ENVIRONMENTAL	PROJECT #: 02-28936-001
STEVE HERNANDEZ	PO#: F028-000
C/O FEDERAL EXPRESS	ITEM #: 02022913 4AL
520 LAWERNCE EXPRESS WAY	DATE: 12/02/93
SUNNYVALE CA 94086	

CYLINDER #: ALM010841 ANALYTICAL ACCURACY: +/-1%NIST
 FILL PRESSURE: 2000 PSIG
 BLEND TYPE : CERTIFIED MASTER GAS

COMPONENT	REQUESTED GAS CONC MOLES	ANALYSIS (MOLES)
NITRIC OXIDE	10. PPM	10.36 PPM
NITROGEN - OXYGEN FREE	BAL	BAL
NOX		10.39 PPM

2000 PSIG BIN #1 12-01
 GRAVIMETRIC MASTER GAS
 AGAINST NIST CERTIFIED WEIGHT
 INDEPENDENT LABORATORY

CERTIFIED TO HAVE BEEN BLENDED
 AND VERIFIED TO BE CORRECT BY
 ANALYSIS.

ANALYST: *R. Steady*

R E P O R T O F C A L I B R A T I O N
LIQUID-IN-GLASS-THERMOMETER

CALIBRATED BY EVER READY THERMOMETER CO.

MARKED: ERTCO 611-3FC S/N-2269

RANGE: -20 TO +110 DEGREES C IN 1 DEGREE GRADUATIONS.

THERMOMETER READING	CORRECTION (ITS-90)**
0.0 C	0.0 C
37.0	-0.1
56.0	0.0

** ALL TEMPERATURES IN THIS REPORT ARE BASED ON THE INTERNATIONAL TEMPERATURE SCALE OF 1990 (ITS-90) PUBLISHED IN THE METROLOGIA 27, NO. 1, 3/10/90.

THIS THERMOMETER WAS CALIBRATED AGAINST A STANDARD CALIBRATED AT THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST) FORMERLY THE NATIONAL BUREAU OF STANDARDS (NBS).

FOR A DISCUSSION OF ACCURACIES ATTAINABLE WITH SUCH THERMOMETERS SEE NBS MONOGRAPH 150.

IF NO SIGN IS GIVEN ON THE CORRECTION, THE TRUE TEMPERATURE IS HIGHER THAN THE INDICATED TEMPERATURE; IF THE SIGN GIVEN IS NEGATIVE, THE TRUE TEMPERATURE IS LOWER THAN THE INDICATED TEMPERATURE. TO USE THE CORRECTIONS PROPERLY, REFERENCE SHOULD BE MADE TO THE NOTES GIVEN BELOW.

THE THERMOMETER WAS TESTED IN A LARGE, CLOSED-TOP, ELECTRICALLY HEATED, LIQUID BATH, BEING "IMMERSED" 76MM. THE TEMPERATURE OF THE ROOM WAS ABOUT 25 DEGREES C (77 DEGREES F). IF THE THERMOMETER IS USED UNDER CONDITIONS WHICH WOULD CAUSE THE AVERAGE TEMPERATURE OF THE EMERGENT LIQUID COLUMN TO DIFFER MARKEDLY FROM THAT PREVAILING IN THE TEST, APPRECIABLE DIFFERENCES IN THE INDICATIONS OF THE THERMOMETER WOULD RESULT.

THE TABULATED CORRECTIONS APPLY PROVIDED THE ICE POINT READING IS 0.0 DEGREES C. IF THE ICE-POINT READING IS FOUND TO BE HIGHER (OR LOWER) THAN STATED, ALL OTHER READINGS WILL BE HIGHER (OR LOWER) TO THE SAME EXTENT.

TEST NUMBER: 140381

DATE: 06/21/90

STANDARD SERIAL NO. 128239

NIST IDENTIFICATION NO. 88024



EVER READY THERMOMETER CO.



METER BOX TEMPERATURE READOUT CALIBRATION

CALIBRATED BY: Robert Nguyen

DATE: 06-16-93

	<u>Inlet (°F)</u>	<u>Outlet (°F)</u>	<u>Thermometer (°F)</u>
BOX 1A	32	32	32 (0 °C)
	77	76	77 (25 °C)
	212	211	212 (100 °C)
BOX 2A	32	32	32 (0 °C)
	76	76	77 (25 °C)
	213	213	212 (100 °C)
BOX 3A	28	27	32 (0 °C)
	75	75	77 (25 °C)
	213	213	212 (100 °C)

NOTE:

Thermometer Standard Serial Number: 128239

Thermometer NIST I.D. Number: 88024



THERMOCOUPLE CALIBRATION

CALIBRATED BY: Robert Nguyen

DATE: 06-16-93

Thermocouple number	Thermocouple reading (°C)	Thermometer reading (°C)
TC-1	0.0	0.0
	26.5	26.5
	100.0	100.0
TC-2	OUT OF SERVICE	
TC-3	0.0	0.0
	27.5	26.5
	99.0	100.0
TC-4	OUT OF SERVICE	
TC-5	0.0	0.0
	26.6	26.5
	99.0	100.0
TC-6	0.0	0.0
	26.5	26.0
	100.0	100.0
TC-7	0.0	0.0
	26.2	26.0
	100.0	100.0
TC-8	0.0	0.0
	26.3	26.0
	100.0	100.0
TC-9	0.0	0.0
	26.6	26.0
	100.0	100.0

TC-10	0.0	0.0
	26.3	26.0
	100.0	100.0
TC-11	0.0	0.0
	26.0	26.0
	100.0	100.0
TC-12	0.0	0.0
	26.0	25.0
	100.5	100.0
C-1	NOT AVAILABLE	
C-2	NOT AVAILABLE	
S-1A	0.0	0.0
	25.8	26.0
	99.0	100.0
S-2A	0.0	0.0
	25.5	26.0
	99.0	100.0
S-16A	0.0	0.0
	25.7	26.0
	99.0	100.0
S-17A	0.0	0.0
	25.9	26.0
	99.0	100.0

Thermometer Standard Serial Number: 128239
 Thermometer NIST I.D. Number: 88024



DIGITAL THERMOMETER CALIBRATION

CALIBRATED BY: Robert Nguyen

DATE: 06-16-93

<u>Digital Thermometer</u>	<u>(°F)</u>	<u>Thermometer (°C)</u>
	32.0	0.0 (32 °F)
Fisher	80.0	26.5 (80 °F)
	210.0	99.0 (210 °F)

<u>Digital Thermometer</u>	<u>(°C)</u>	<u>Thermometer (°C)</u>
	1.0	0.0
Omega	26.0	26.5
	98.0	98.0

<u>Digital Thermometer</u>	<u>(°C)</u>	<u>Thermometer (°C)</u>
	1.0	0.0
Fluke (T1)	27.5	26.5
	99.0	98.0

<u>Digital Thermometer</u>	<u>(°C)</u>	<u>Thermometer (°C)</u>
	1.1	0.0
Fluke (T2)	27.4	28.0
	99.0	98.0

NOTE:

Thermometer Standard Serial Number: 128239

Thermometer NIST I.D. 88024

DATE: 3-31-93 OPERATOR: Paul Henderson
 Model S-190
 DRY GAS METER IDENTIFICATION: 25507 MTM IDENTIFICATION: AL-20 10103
 BAROMETRIC PRESSURE (P_b): 29.55 in. Hg
 (Note: P_b was falling during calibration)



APPROXIMATE FLOW RATE (Q) cfm	WET TEST METER GAS VOLUME (V _s) ft ³	DRY GAS METER VOLUME (V _{dg}) ft ³	TEMPERATURES			DRY GAS METER PRESSURE (ΔP) in H ₂ O	TIME (θ) min.	FLOW RATE (Q) cfm	METER METER COEFFICIENT (Y _{dg})	AVERAGE METER COEFFICIENT (Y _{dg})
			WET TEST METER (T _f) °F	INLET (T _i) °F	OUTLET (T _o) °F					
0.40	A	0.000	74	—	77.1	-1.35	13.0	0.407	1.008	1.008
	B	5.420	74	—	77.4	-1.35	13.0	0.405	1.008	
	C	0.000	74	—	77.4	-1.35	13.0	0.405	1.009	
0.60	A	0.000	74	—	77.4	-2.35	12.0	0.606	1.010	1.010
	B	7.425	74	—	77.4	-2.35	12.0	0.603	1.009	
	C	0.000	74	—	77.4	-2.35	12.0	0.604	1.012	
0.80	A	0.000	74	—	78.2	-3.65	12.0	0.822	1.010	1.010
	B	10.122	74	—	78.2	-3.65	12.0	0.822	1.010	
	C	0.000	74	—	78.2	-3.65	12.0	0.822	1.010	
1.00	A	0.000	74	—	78.2	-5.15	10.0	1.008	1.009	1.009
	B	10.356	74	—	78.2	-5.15	10.0	1.007	1.009	
	C	0.000	74	—	78.2	-5.15	10.0	1.005	1.009	
1.20	A	0.000	74	—	78.2	-7.10	9.0	1.203	1.008	1.007
	B	11.132	74	—	78.2	-7.10	9.0	1.204	1.007	
	C	0.000	74	—	78.2	-7.10	9.0	1.201	1.007	

$$Q = 17.65 \frac{V_s}{P_b} \times \frac{P_b}{(T_s + 460)} \times \frac{Y_{dg}}{(P_b + \Delta P)} \times \frac{P_b}{13.6}$$

Reference Dry Gas Meter No. 25507 Rockwell

Calibration Date 12-28-93 Calibrated by:

	1	1
AVERAGE	0.997	1.910

MAGNEHELIC CALIBRATION CHECK

UNIT	LOW		MED		HIGH	
	Mag	Man	Mag	Man	Mag	Man
05-24-93						
JW16 (0-1")	0.10	0.10	0.47	0.47	0.90	0.90
GF17 (0-0.5")	0.060	0.060	0.260	0.260	0.470	0.485
CA59 (0-4")	0.50	0.50	1.70	1.70	3.50	3.50
07-30-93						
R15E (0-1")	0.12	0.12	0.49	0.49	0.82	0.82
JW16 (0-1")	0.12	0.12	0.50	0.50	0.82	0.82
GF17 (0-0.5")	0.065	0.060	0.260	0.260	0.430	0.420
CA59 (0-4")	0.40	0.38	1.90	1.90	3.40	3.40
11-26-93						
R15E (0-1")	0.11	0.10	0.51	0.51	0.87	0.87
JW16 (0-1")	0.10	0.10	0.51	0.51	0.89	0.89
GF17 (0-0.5")	0.050	0.045	0.250	0.250	0.430	0.440
CA59 (0-4")	0.51	0.49	2.02	2.00	3.65	3.65

Readings in " H₂O

Reference: Oil Manometer - Dwyer #400-10
0-1" inclined, 1-10" vertical



PRECISION
INSTRUMENT
REPAIR

PRECISION INSTRUMENT REPAIR CO.

13414 WOODRUFF AVE., BELLFLOWER, CA. 90706

310 /925-6672

REPORT NO: 3916

Certification Report Of Precision Balances and Scales

This is to certify that the balance calibrated is in compliance to US GOVERNMENT MILITARY BOOKLET, MIL-STD-45662A and that the standards used meet the compliance of NIST (NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY)

PRODUCT ORIGINAL CONDITION: In working order.

☒ CALIBRATED AT IN-USE LOCATION ☐ CALIBRATED AT P.I.R. OFFICE.

TEMPERATURE: 70°F HUMIDITY: 59% STANDARD USED: Class I S/N 5943

MANUFACTURER, MODEL, SERIAL NUMBER OF PRODUCT CALIBRATED

1 TORSION TORBAL EA-1 ANALYTICAL BALANCE, S/N 156636

Calibrated to: 100mg=100.0mg
Linearity: OK
Maximum Load: OK
Repeteability: OK



COMPANY OR PRODUCT OWNER:

PACIFIC ENVIRONMENTAL SERVICES
13100 BROOKS, SUITE 100
BALDWIN PARK, CA. 91706
ATTN: SIYA

PO# 0640-102

Date of Calibration 12-21-93 Technician Tom Benson License 1-0903



HYDROCARBON CYLINDERS
VOLUME CALIBRATION
08-20-90

<u>Cylinder #</u>	<u>Full, lbs</u>	<u>Tare, lbs</u>	<u>Net, lbs</u>	<u>Volume, L</u>
101	31.33	4.45	26.88	12.22
102	32.65	5.83	26.82	12.19
103	31.60	4.69	26.91	12.23
104	31.65	4.68	26.97	12.26
105	31.42	4.47	26.95	12.25
106	32.62	5.82	26.80	12.18
107	31.14	4.50	26.64	12.11
108	32.45	5.98	26.47	12.03
109	31.22	4.69	26.53	12.06
110	31.15	4.68	26.47	12.03

Supplemental Set 07-29-92

111	31.42	4.86	26.56	12.07
112	32.44	5.86	26.58	12.08
113	32.44	5.96	26.48	12.03
114	31.50	4.48	27.02	12.28
115	32.45	5.90	26.55	12.06
116	31.55	4.45	27.10	12.31
117	31.35	4.71	26.64	12.10
118	32.62	6.04	26.58	12.08
119	31.40	4.73	26.67	12.12
120	31.50	4.78	26.72	12.14

Note: Cylinders were filled to the rim (not including fittings)
with water and weighed on a 125-lb capacity platform balance.

Water density at room temperature = 0.997 gm/cc or 0.0022 lbs/cc.

Pitot Tube Calibration Data Sheet

Calibrated by: Angela Miller

Date: 12-30-93

Pitot Tube I.D. S-17A

Effective Length: 5'

Pitot Tube Assembly Level ? ☒ Yes ☐ No

Pitot Tube Openings Damaged ? ☐ Yes ☒ No

If Yes, Explain _____

$\alpha_1 =$ θ $^{\circ} (<10^{\circ})$

$\alpha_2 =$ θ $^{\circ} (<10^{\circ})$

$\beta_1 =$ θ $^{\circ} (<10^{\circ})$

$\beta_2 =$ θ $^{\circ} (<10^{\circ})$

$\gamma =$ θ $^{\circ}$ $\theta =$ θ $^{\circ}$ $A =$ 0.954 $^{\circ}$

$Z = A \sin \gamma =$ θ cm (in.) 0.32 cm ($< \frac{1}{8}$ in.)

$W = A \sin \theta =$ θ cm (in.) 0.08 cm ($< \frac{1}{32}$ in.)

$P_A =$ 0.477 cm (in.)

$P_B =$ 0.477 cm (in.)

$D_t =$ 0.375 cm (in.)

Comments: _____

Calibration Required ? ☐ Yes ☐ No